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ARCHIVES

OF

OTOLOGY

EDITED IN ENGLISH AND GERMAN

BY

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OF NEW YORK.

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AND

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IN CONJUNCTION WITH

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VOLUME VIII

NEW YORK:
G. P. PUTNAM'S SONS, 182 FIFTH AVENUE.

WIESBADEN: J. F. BERGMANN'S Verlag.
LONDON: N. TRUEBNER & Co., 59 Ludgate Hill.
PARIS: J.-B. BAILLIERE, 19 Rue Hautefeuille.

1879.

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Press of
G. P. Putnam's Sons,
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CONTENTS OF VOLUME VIII.

NUMBER 1.

1. Primary Acute Purulent Inflammation of the Middle Ear. By H. Knapp. 1

2. On the Formation of Sequestra in the Mastoid Process of the Child. By Dr. Arthur Hartmann, of Berlin. Translated by Dr. James A. Spalding, of Portland, Maine. 26

3. On the Sinus Tympani. By Dr. H. Steinbrügge, in Heidelberg. Translated by Dr. James A. Spalding, of Portland, Maine. . 53

4. Experiments with Edison's Phonograph. By Dr. Oscar Wolf, of Frankfort-on-the-Main. Translated by Dr. Swan M. Burnett, of Washington, D. C. (With six woodcuts.) 58

5. Clinical Contributions to Otology. From the Practice of Dr. C. R. Agnew. Reported by Dr. David Webster, of New York. . 65

6. Extensive Caseous Osteitis of the Mastoid Process and Petrous Bone, Caused by Chronic Purulent Inflammation of the Middle Ear.—Operation.—Permanent Fistula of the Mastoid.—Recovery. By A. G. Gerster, M.D., of New York. 81

7. On the Indications for Opening the Mastoid Process in Cases of Otitis Media Purulenta Acuta with Implication of the Mastoid Cells. By Dr. Emil Gruening, of New York. 84

8. Report on the Progress of Otology in the first half of the Year 1878.

I. Normal and Pathological Anatomy and Histology of the Organ of Hearing. By H. Steinbrügge, of Heidelberg. Translated from the German edition, by Isidor Furst, of New York. 89

II. Physiology of the Organ of Hearing. By Oscar Wolf, of Frankfort-on-the-Main. Translated by Isidor Furst, of New York. 98

III. Embryology and Comparative Anatomy of the Organ of Hearing. By L. Löwe, of Berlin. Translated by Isidor Furst, of New York. 104

NUMBER 2.

1. Contributions to the Pathology and Pathological Anatomy of the Organ of Hearing, by Prof. S. Moos. Translated by Dr. Swan M. Burnett, of Washington, D. C. 113

2. A Case of Objective Aural Sounds. By Dr. E. L. Holmes, of Chicago. 144

3. Four Cases of Intracranial Disease Caused by Chronic Suppuration of the Middle Ear. Two Recoveries and Two Deaths. By Dr. Charles J. Kipp, of Newark, N. J. 147

4. Condylomata of Both External Ear Canals. By H. Knapp. . 165

5. A Case of Tumor of the Auditory Nerve Occupying the Fossa for the Cerebellum. By Geo. T. Stevens, M.D., of Albany, N. Y. 171

6. A New Test for Simulated One-sided Deafness. By David Coggin, M.D., of Salem, Mass. 177

7. Note on the Treatment of Acute Suppuration of the Middle Ear. By Dr. Edward T. Ely, of New York. 178

8. Abstract of American Otological Literature for the first quarter of 1879. By Dr. Swan M. Burnett, of Washington, D. C. . . 183

9. Report on the Progress of Otology in the first half of the Year 1878. (Continued from page 111.) . . . . . .

IV. Pathology and Therapeutics of the Organ of Hearing. By A. Hartmann, of Berlin. Translated by Isidor Furst, of New York. 187

I. Normal and Pathological Anatomy and Histology of the Organ of Hearing. By H. Steinbrügge, of Heidelberg. Translated by Isidor Furst, of New York. . . . 205

II. Physiology of the Organ of Hearing. By Oscar Wolf, of Frankfort-on-the-Main. Translated by Isidor Furst, of New York. 207

NUMBER 3.

1. An Instrument for Removing Fluids from the Tympanum. By Dr. Schalle, of Hamburg. Translated by James A. Spalding, M.D., Portland, Maine, ... 215

2. A Case of Closure of the Auditory Meatus and loss of Hearing by the Formation of Exostoses, Complicated with Acute Perforative Inflammation of the Middle Ear, with Repeatedly Recurring Granulations.—Restoration by the Use of Laminaria and Galvano-Cautery. By S. Moos, of Heidelberg. Translated by James A. Spalding, M.D., Portland, Maine. 223

3. The Use of Toynbee's Artificial Ear-Drum. By Charles E. Hackley, M.D., of New York. 228

4. Four Cases of Severe Disease of the Mastoid Process. By S. Moos, of Heidelberg. Translated by James A. Spalding, M.D., Portland, Maine. 231

5. On Branchial Fistulæ at the External Ear. By Dr. D. Schwabach, of Berlin. Translated by James A. Spalding, M.D., of Portland, Maine. 246

6. Analysis of the Tones Included in the Secondary Noise of an Intermitting Tuning-Fork. By Dr. E. Berthold, of Königsberg. Translated by James A. Spalding, M.D., of Portland, Maine. . 250

7. A Case of Acute Inflammation of the Middle Ear, with Inflammation of the Muscles of the Neck, and Facial Paralysis of the same side. Recovery. With some Remarks upon the Indications for Wilde's Incision and Trephining the Mastoid Process. By Dr. D. B. St. John Roosa, of New York. 255

8. The Histology of the Inferior Turbinated Bones, and of the Teleangiectatic Fibromata arising from them. By H. Steinbrügge, M.D., of Heidelberg. Translated by Dr. Richard C. Brandeis, New York. (With Plates I and II.) 269

9. Abstract of American Otological Literature for the Second Quarter of 1879. By Swan M. Burnett, Washington, D. C. . . 284

10. Report on the Progress of Otology in the first half of the Year 1878. IV. Pathology and Therapeutics of the Organ of Hearing. By A. Hartmann, of Berlin. Translated by Isidor Furst, of New York. 288

NUMBER 4.

1. A Case of Parotidean and Intra-Tympanic Malignant Tumor. By H. Knapp. With notes from Drs. H. B. Sands and A. H. Buck of New York, and Drs. S. H. Peck and S. J. Parker of Ithaca, N. Y. 311

2. On Sclerosis of the Mastoid Process. By Dr. Arthur Hartmann, Berlin. Translated by James A. Spalding, M.D., Portland, Me. 322

3. On a Traumatic, Movable Haematoma of the Membrana Tympani. By Prof. S. Moos, of Heidelberg. Translated by James A. Spalding, M.D., Portland, Me. 332

4. Syphilitic Diseases of the Internal Ear. Being a Review of some Recents Papers upon this Subject. By D. B. St. John Roosa, M.D. 336

5. ——— A New Aural Douche. 355

6. Objective Aural Sounds Produced by Voluntary Contraction of the Tubal Muscles. By Swan M. Burnett, M.D., of Washington, D.C. 357

7. Report of the Proceedings of the Section of Otology of the British Medical Association, held at Cork, August, 1879. (Being an abstract of the Report published in the *British Medical Journal*, August 30, 1879.) By Dr. F. P. Capron, of Yonkers, N.Y. . 360

8. An Abstract of American Otological Literature for the Third Quarter of 1879. By Swan M. Burnett, of Washington. . . 370

9. The Audiphone and Dentaphone. By Chas. S. Turnbull, M.D., of Philadelphia. (With two wood-cuts.) 373

10. Report of the Progress of Otology in the second half of the Year 1878.

I. Report on Normal and Pathological Anatomy. By Dr. H. Steinbrügge. Translated by James A. Spalding, M.D., Portland, Me. 381

II. Physiology of the Organ of Hearing. By Dr. Oscar Wolf, of Frankfort-on-the-Main. 388

IV.* Pathology and Therapeutics of the Organ of Hearing. By Dr. A. Hartmann, Berlin. 399

* Section iii, Embryology and Comparative Anatomy of the Ear, had, for want of space, to be reserved for the next number.

PREFACE.

THE ARCHIVES OF OTOLOGY are the continuation of the otological part, and the Archives of Ophthalmology the continuation of the ophthalmological part of the *Archives of Ophthalmology and Otology*. This division has been made, both for the convenience of many readers, who practice either ophthalmic or aural surgery exclusively, and for the sake of doing justice to the growing importance of the literature in both departments. The English and the German edition have hitherto contained the same original papers, either in the language of the authors or in faithful translations. This plan will be essentially continued; but if the contributions become too numerous, some papers will be abridged in the translation. The editors will take care that by this condensation as little as possible of the author's investigation and thought is lost. If a paper is not translated *in extenso*, it will be so stated, in order to admit of reference to the original, should controversies of priority occur.

The review of the current literature, hitherto contained in the English edition only and consisting of selections, will in future appear in both editions and constitute a systematic and complete, though concise report on the progress of Otology.

Profiting by their past experience and relying on a great number of prominent men as regular contributors, the editors feel assured of being able to furnish to their readers a *good journal*, presenting the actual state and the progress of aural surgery in all its branches. In their selections the editors will give preference to those original papers in which speculation and theory are subordinate to observation and fact.

ARCHIVES OF OTOLOGY.

PRIMARY ACUTE PURULENT INFLAMMATION OF THE MIDDLE EAR.*

By H. KNAPP.

WHEN I began practice in New York ten years ago, so many cases of acute inflammation of the middle ear fell under my notice that I was led to the inference that acute diseases of the ear were relatively more frequent in this country than in Europe, particularly in Germany. I thought that this disproportion was owing to the climate and situation of my new dwelling-place. The climate of New York is distinguished not only by the extremes of heat and cold during the year, but by abrupt and great changes of temperature during the same day. Only two to three months in the year, from the middle of September to the beginning of December, are free from these sudden changes, showing a mild and uniform climate, which, I think, is as pleasant and exhilarating as may be found anywhere on the globe. Among the beauties of the American autumn, I will mention only the gorgeousness and long duration of the changing colors of the forest, that astonish every European. The situation of New York near the ocean, favors, on account of the well-known dangers of sea-bathing, the occurrence of acute inflammation of the ear. These considerations, which I have always kept in mind, have originated the following paper, in which I purpose to discuss one of the most important of the acute diseases of

* Read before the Medical Society of County of New York, February 24th, 1879.

the ear, the primary perforative otitis media, in regard to its relative frequency, its etiology, duration, termination, and the results of different modes of treatment. The discussion will be based on a somewhat extensive material of personal observation, yet comparison with the experience of others will not be omitted. In describing the causes and the course of the disease under consideration, I shall make use of my private practice only, since the observations and notes taken from private patients are more detailed and reliable than those taken from hospital patients. I beg here to state that no patient is counted twice. If a patient went from clinical into private practice, or *vice versa*, this was noted in the book, and he received no new number, but the number of the last patient, with an index, in order to find his case readily by means of the register, without introducing errors into the statistics of the diseases observed. My books are so arranged that only the new patients receive new, successive numbers, and those who, at the end of the year, remain under treatment are not entered again, nor such as return with a relapse of a disease for which they were treated in previous years. Furthermore, I beg to state that patients, not diseases, have been counted. If a patient suffered from two or more diseases in one or both ears, the diagnosis of the most important only was counted in the statistics.

I. Relative Frequency of Acute Otitis Media as to the Total Number of Ear Diseases.

During the last ten years I have treated in private practice 2,527 cases of ear disease, among which there were 182 of acute otorrhœa, *i. e.*, 7.2 per cent. In the hospital I have treated, in conjunction with the assistant surgeons (Pooley, Aub, Gruening, Gebser, C. Williams, Alt, Born, and others), during nine years, 6,102 ear patients, among whom 382, *i. e.*, 6.26 per cent., suffered from acute purulent otitis media. My private and clinical material of ear disease consequently amounted to 8,229 patients, among whom there were 564 cases of acute otorrhœa, which, therefore, represented 6.53 per cent. of the total number of ear diseases. In order to see

how this agrees with the observations of others, I have compiled and arranged in the following table the statistics of some American and European aural clinics and surgeons that make special mention of otitis media purulenta acuta. The data which have served for the calculation, are stated in the subsequent references.

INSTITUTIONS OR SURGEONS.	YEARS.	Total number of Ear Patients.	Number of acute otorrhœa.	Percentage of otorrhœa to total number.
H. Knapp (private practice) . . .	1869–1878	2,527	182	7.2
N. Y. Ophthalmic and Aural Institute, 1 .	1869–1877	6,102	382	6.26
Dr. Roosa (private practice) 2 . . .	1869	500	15	3.00
" " " 3 . . .	1871	494	17	3.44
N. Y. Eye and Ear Infirmary, 4 . .	1874	2,439	77	2.91
" " " " 5 . .	1876	2,410	137	5.68
" " " " 6 . .	1877	2,679	99	3.69
Manhattan Eye and Ear Hospital, 7 . .	1869–1878	5,803	499	8.59
Brooklyn Eye and Ear Hospital, 8 . .	1876	874	76	8.69
Ear Department of the Philadelphia Dispensary (Dr. G. Strawbridge) 9 . . .	1870–1875	2,760	143	5.18
Dr. Spencer, 10	1873	255	29	11.37
" " 11	1872	166	9	5.42
Dr. C. H. Burnett, 12	1875	350	7	2.00
Total of American observations . . .		27,359	1,666	6.08
Prof. Schwartze (clinic)	1864–1871	1,406	116	8.25
Dr. Schalle (Military Hospital, Dresden) 14	1877	300	34	11.33
Dr. Hedinger, 15	1877	3,679	219	5.95
Dr. Poorten, 16	1874	1,040	38	3.65
Dr. Moos (clinic) 17	1864–1866	137	5	3.65
Total of European observations . .		6,562	416	6.27

Literary references to the foregoing table:

1. First to eighth Annual Reports.

2. Roosa: New York Med. Journ., Vol. V., page 514.

3. Roosa: Statistical Report of 494 cases of diseases of the ear. Am. Journ. Med. Sciences. No. 6, Bd. XXII., page 386.

4. Fifty-fourth Annual Report.

5. Fifty-sixth. " "

6. Fifty-seventh. " "

7. The next report, the MS. of which I was permitted to use by the kindness of Dr. C. R. Agnew.

8. Seventh Annual Report.

9. Report, 1876.

10. Statistical Report of 225 cases of diseases of the ear. Transactions of the Med. Assoc. of the State of Missouri, 1873.

11. St. Louis Med. and Surg. Journ., 1872.

12. Second Annual Report of the Philadelphia Infirmary for Diseases of the Ear, 1875.

13. Arch. f. Ohrenhlkde., Bd. I–VI.

14. Bericht über die Ohrenstation im Garnisonslazareth zu Dresden. Arch. f. Ohrenhlkde., Bd. XII, pag. 49 u. 50.

15. Mittheilungen aus der Ohrenpraxis. Würt ärztl. Corresp.-Bl., 1877, No. 6, 7 u. 8.

16. Mittheilungen aus der otiatrischen Praxis. Dorpater Med. Zeitschr., Bd. IV., Heft 2, 3 u. 4.

17. Anhang zum zweiten und dritten Jahresbericht der Augenklinik des Dr. H. Knapp zu Heidelberg.

In reviewing the preceding table, we find considerable variations in the statements of different observers and different institutions. These variations, however, become less marked the greater the material of observation. Acute otorrhœa seems to occur as frequently among the wealthy as among the poor, since private practice shows no essential difference from hospital practice. I should have liked to collect a greater number of German observations, but the statistical material was wanting. In the otherwise very detailed reports of Gruber, acute otorrhœa is not separated from chronic. These reports were consequently not available for the present purpose. This holds good also of Blake's reports of the Massachusetts Charitable Eye and Ear Infirmary.

What surprised me most, was the fact demonstrated by the preceding table, that the acute purulent inflammation of the middle ear occurs about as frequently in Europe as in America. The sum of all the European observations, as far as collected, shows almost the same percentage of acute otitis media purulenta, with reference to the whole number of ear diseases, that I have observed at my clinic in nearly an equal number of patients, the proportion being in both cases 6.27 per cent. The sum total of American observations, 27,350, furnishes 1,666 cases of acute otorrhœa, i. e., 6.08 per cent. This is even a somewhat smaller percentage than that derived from the sum total of European observations, 6,562 patients with 416 cases of acute otitis media purulenta, 6.27 per cent. The annual reports of the N. Y. Ophthalmic and Aural Institute contain specified classifications of all ear diseases. To enter into similar details as to

private patients, would here be out of place, yet it may not be inappropriate to classify the cases of private practice in large groups, in order to show the statistical importance of acute purulent otitis media in comparison with the other ear diseases:

Diseases of the external ear . . .	331	*i. e.*,	13.10 per cent.
Acute otitis media catarrhalis . . .	206	"	8.15 "
Chronic " " . . .	1,120	"	44.32 "
Acute " purulenta . . .	182	"	7.20 "
Chronic " " . . .	591	"	23.39 "
Diseases of the inner ear . . .	99	"	3.84 "
Total	2,527	"	100.00 "

I have tabulated the clinical histories of the 182 cases of acute otitis media, to serve as a basis for the deductions of general results, which I shall illustrate by a number of typical cases, since space and your patience would not permit the reproduction of the entire tabular statement.

II. OCCURRENCE OF ACUTE OTORRHŒA, WITH REFERENCE 1st, TO THE AGE OF THE PATIENT; 2d, THE SEASON OF THE YEAR, AND 3d, ITS AFFECTING ONE OR BOTH EARS.

The influence of the age of the patient is illustrated by the following table:

AGE OF PATIENTS	NUMBER OF CASES.	PER CENT.
0–05	37	20.33
6–10	22	12.19
0–10	59	22.42
11–20	23	12.64
21–30	32	17.58
31–40	37	20.33
41–50	21	11.54
51–60	7	3.85
61–70	1	0.55
71–80	2	1.09
	182	

The table shows that the greatest contingent is furnished by the age of childhood, particularly the period from birth to the fifth year; next in relative frequency is the period from the 6th to the 10th year; then the age of the most robust manhood, from the 31st to the 40th year. It is evi-

dent that age alone does not suffice to form a correct estimate of the occurrence of a disease, but we have also to take into consideration the different obnoxious influences that are prevalent at certain ages. Childhood is in a more unfavorable condition than mature age, not only on account of the low power of resistance on the part of the youthful organism, but also on account of some important diseases predominantly inherent to it, above all, the acute exanthemata. In this respect our table falls short of representing the real frequency, since the acute affections of the ear, resulting from scarlet fever and other general diseases, generally do not come under the care of the specialist, or if they do, it is only when they have become chronic, and consequently lie outside the pale of our table.

2d. *The season of the year* furnishes the following results:

January	21 patients.	July	9 patients.
February	25 "	August	14 "
March	14 "	September	14 "
April	19 "	October	4 "
May	20 "	November	12 "
June	16 "	December	18 "

This table shows that the winter months furnish a considerably larger number of acute suppurative inflammation of the middle ear than the summer months. I will here mention that the New York summer, that is the warm season, lasts from May 15th to November 15th. The warm months showed 69, that is 38 per cent.; the cold months 113, that is 62 per cent. of cases of acute otorrhœa. In places not situated near the ocean, the percentage is still more in favor of summer, on account of the absence of the dangers from sea-bathing.

3d. In regard to the one-sided or double-sided occurrence of the disease, the tabulated statement shows that both sides were affected with acute perforative inflammation of the middle ear in 26 cases, that is 14.29 per cent.; one side alone in 156 cases, that is 85.71 per cent. I should not omit to mention that in the great majority of cases both ears suffered, but perforation of the membrana tympani occurred in one only. The acute non-perforating inflammations of the

middle ear have all been entered as acute aural catarrhs, and since only the number of diseased persons, and not of diseased ears, has been noted, a simultaneous milder disease of the other ear has not been included in the statistics.

III. Etiology.

The causes of acute suppurative inflammation of the middle ear, arranged according to their relative frequency, were the following:

Pharyngitis and rhino-pharyngitis	68 cases,	37.36	63.74 per cent.
Coryza and assignable exposure	48 "	26.37	
Sea-bathing	16 "	8.19	"
Scarlet fever	13 "	7.14	"
Diphtheria	4 "		
Measles	3 "		
Pneumonia	3 "		
Improper use of nasal douche	3 "		
Cold water and alcohol run into the ear	2 "		
Eczema of external ear	1 "		
Mumps	1 "		
Varioloid	1 "		
Causes unknown	19 "		

The first place, with 63.74 per cent., is occupied by the consequences of exposure to cold, manifesting themselves in inflammation of the naso-pharyngeal mucous membrane and its continuation into the middle ear, in the well-known manner. A part of the patients showed a constitutional predisposition, for instance scrofula, tuberculosis, syphilis, and the like. In others, acute naso-pharyngeal catarrh developed into acute purulent otitis media; in many others, the otorrhœa set in without any predisposing causes by the action of unfavorable physical conditions, as we see primary iritis or pneumonia occur. Exposure by standing in cold water, rapid cooling of the body, draughts during perspiration and sea voyages, were the most common causes of the primary purulent inflammation of the middle ear.

Sea-bathing enters with 8.78 per cent. into the etiological table. This number is not very high, if the manifold obnoxious influences connected with sea-bathing are taken into account. As such, I may specially mention:

1. *The local action of sea-water on the membrana tympani and the inner portion of the external auditory canal,* readily extending to the middle ear on account of the tenuity of the partition-wall and its vascular connection with the drum cavity.

Sea-water is injurious:

a. By its low temperature. "The ear suffers nothing cold," says the layman, and the aurist is familiar with the damaging effect of cold liquids that penetrate into the middle ear by way of the Eustachian tube or external meatus. Even without penetrating, but acting long and intensely upon the "door" of the middle ear—the membrana tympani—and its surroundings, cold liquids may bring about acute suppuration of the middle ear, as will be more conclusively shown hereafter.

b. By the large quantity of salt it contains, causing a direct irritation to the drum membrane and its adjacent parts.

c. By its impulse; the mechanical irritation of the membrana tympani and its surroundings causing congestion and swelling of tissue, according to the well-known "beating experiment" (Klopfversuch) of the skin. The inhabitants of places remote from the sea can hardly form an idea of the force with which the surf whips, stuns, and overthrows the bathers.

In Long Branch, for instance, one of the most popular sea-bathing resorts in the vicinity of New York, ropes are drawn from the shore into the ocean, and fastened to spiles to protect bathers from the dash of the surf. In spite of this, ladies and children seldom venture out into the water without the arm of a robust man.

d. By its contamination with fine sand, slime, small animals and plants. These substances are difficult to remove from the ear, and find a convenient lodging-place in the sinus between the lower portion of the membrana tympani and the adjacent part of the auditory canal, where they cause inflammatory irritation both by mechanical and chemical actions.

2. The prejudicial effect of the local action of sea-water is increased by some of the *physical properties of the ocean*

bath, acting on the system. For instance, the great loss of heat in the whole body, the damp and cold sea air, and the damp bed linen and covers, are apt to occasion inflammation of the middle ear, by the mediation of rhinopharyngitis.

Since sea-bathing in this way acts injuriously on the ear from within and without, it is but right that aurists should caution their patients against it. The occurrence of chronic aural catarrh, with thickening of the drum-head, in consequence of frequent bathing in the ocean, is mentioned by many aurists, and Dr. C. H. Burnett * illustrates it by the interesting remark, "that he is informed by a physician of the South, and it is a fact well known to others, that hunting dogs, taught to dive, become deaf."

If, in spite of what has been said, thousands of people each year enjoy sea-bathing with impunity, we have to see in this fact only an additional example of the well-established truth that every cause of disease produces actual illness only in a limited number of those who expose themselves to its action. With regard to the etiology of aural disease, I may be allowed to cite the high degree of immunity enjoyed by such persons as have passed through their youth without contracting any serious aural affections, provided that deafness be not hereditary in their families.

Scarlet fever is represented with 7.14 per cent. among the causes of acute purulent otitis media. This number is, as stated above, too low, but may be of some value as indicating the small proportion of cases in which the specialist is called upon to take charge of the acute stage of an ear disease which, on multitudes of people, inflicts life-long hardness of hearing, offensive discharge from the ear, frequent extension of the inflammation toward the brain, and, in some cases, death. To complain of this, and to make admonitory remarks, would here be out of place.

Diphtheria was observed in four cases, *i. e.*, almost two per cent., as the cause of acute otitis media purulenta. Since this cause is rather infrequent, I may be permitted briefly to report these cases.

* Treatise on the Ear. Philadelphia, 1877, p. 466.

The *first case* was that of an otherwise healthy boy, æt. 7, who had suffered from a moderately intense faucial diphtheria in May 1873, when the epidemic of diphtheria of the previous winter was in its decline. Two weeks after the beginning of the faucial diphtheria, ordinary aural catarrh developed on one side, but on the other acute otitis media, leading under the usual symptoms to perforation of the drumhead, set in on the third day. The perforation was small, and situated immediately below the umbo. Inflation was easy, and the perforation whistle distinct. The membrana tympani and the mucous membrane of the middle ear showed no diphtheritic appearance. The perforation in the drum membrane closed in two weeks, and, a few weeks after that, perfect recovery, with normal hearing, had taken place. The boy, whom I repeatedly saw some years after his recovery, has never again complained of his ears.

The *second ease* was that of another child, æt. 2, who, in January, 1877, contracted scarlet fever, which was followed by diphtheritic pharyngitis, and, five days later, by perforation of the membrana tympani. I saw the child in consultation with the family physician. There was very intense swelling of the mucous membrane of the middle ear, without diphtheritic infiltration, furthermore, profuse otorrhœa, lasting six months. The disease ran a slow course, but the child finally recovered, the perforation in the drum membrane closed, and the hearing did not seem to be materially impaired.

The *third case* was that of a boy, æt. 5, who was brought to me once only, three weeks after the onset of the otorrhœa. While suffering from diphtheria of the pharynx, he had, for two days, most violent earache, followed by discharge, which had not yet diminished at the time of his presentation. There was a large defect in the drumhead, the mucous membrane of the drum was greatly swollen, bled easily, but was free from diphtheritic deposits.

The *fourth case* was that of a boy, æt. 6, who in January, 1878, had contracted a most intense diphtheria, which terminated fatally. The diphtheria commenced in the fauces, and caused extensive swelling of the walls of the whole bucco-pharyngeal cavity. In the right palatine arch there was a large abscess, which was opened by Dr. Cl. Wagner. The symptoms growing more alarming, the family physician called me in consultation, besides Dr. Wagner. I found the child speechless, in high fever, constantly

moaning, and the walls of the pharyngeal cavity covered with white membranes, some of which were thrown out. The right facial nerve was paralyzed, the whole parotid region, the external ear, and the mastoid region, were hard and swollen. The external auditory meatus, on account of the swelling of its walls, was so much narrowed that the thinnest speculum could not be introduced. A flocculent serous discharge escaped from the external meatus. The eyelids were swollen, tight and red ; the conjunctiva was œdematous ; the eyeballs protruded considerably ; the refracting media were clear ; the retinal veins tortuous and dilated ; the margins of the optic disc ill defined ; the retina was swollen and grayish opaque (retinal œdema). The child died six hours after the consultation. Autopsy not permitted.

Only in the last of these four cases the diphtheritic process extended into the ear. The Eustachian tube may fairly be considered as having been its passage way. The extensive swelling of the neighboring parts, so frequently connected with severe diphtheria, was most marked in this case. Not only the regions of the mastoid process and parotis were involved, as is not uncommon in intense otitis, but also the cellular tissue of the orbit and eyelids. The inflammation may have reached these parts either by way of the spheno-maxillary fissure, or along the facial or jugular veins and the cavernous sinus. I purpose to discuss more in detail this quite extraordinary cause of exophthalmus in the *Archives of Ophthalmology* on another occasion. The presence of a truly diphtheritic process in the middle ear of the child was proven by the sero-flocculent character of the discharge, and the extensive diphtheritic infiltration of the soft parts of the mouth and pharynx. The characteristic stage of diphtheritis conjunctivæ is likewise distinguished by sero-flocculent secretion. As soon as the discharge turns creamy and purulent, and the mucous membrane bleeds readily, the disease has passed from the specifically diphtheritic into the blennorrhoic stage, affording an essentially more favorable prognosis. In the first three cases the blennorrhoic stage had already set in when they came under observation.

Measles and *pneumonia* furnished three cases, *i. e.*, 1.5 per cent.

The *inappropriate use of the nasal douche* produced acute suppurative otitis in three cases.

The *first* has been described by me in the *Archives of Opthalmology and Otology.**

The *second* case was that of a gentleman of Chicago who came under my care in May, 1875. Though his case, as far as observed by me, does not properly belong to this series, his disease being an acute relapse of a previous affection, it is reported here on account of its instructiveness. Five years previously he had been treated for nasal catarrh by one of the most renowned German aurists with injections of solutions of nitrate of silver into the nose. During these injections the liquid happened to enter his left ear through the Eustachian tube, as was manifested by sudden, intense pain in the ear. The pain became more severe during the following two days, and the hearing impaired. The physician perforated the drum membrane, and purulent discharge set in. The patient's ear was treated for two years, but the acuteness of hearing was never so good as it had been before.

The *third* case was that of a lady of New York, æt. 20, who suffered from chronic nasal catarrh, but had never had any affection of the ear. She came under my treatment on May 7th, 1877. Four weeks previously, while she was using the nasal douche, cold water entered the right ear. This accident was immediately followed by sharp pain in the ear, which, however, gradually disappeared. Three days before she came to me, water had again entered the ear,and immediately caused intense pain, which subsided somewhat the next day, but returned with such violence during the following night that she came to me in great distress early the next morning. I found the membrana tympani red and bulging. Mucous râles on Politzer's experiment. I made paxacentesis of the drum, after which the pain at first increased, but subsided toward evening, when profuse purulent discharge of the ear set in. The acute inflammatory symptoms lasted some weeks; the perforation of the membrana tympani closed on the 4th of July, and some weeks later her hearing was normal.

In chronic affections of the ear I have more frequently witnessed the injurious effect of water passing into the ear through the Eustachian tube. Only *cold* water produced

* Vol. I, page 365–376. 1869.

severe symptoms, among which sudden intense pain was the most notable. In the majority of cases this pain disappeared in a few hours without leaving any consequences. A few times I had an opportunity to examine the membrana tympani under these conditions with an ear-mirror, and found it more or less uniformly red, as it is seen in acute aural catarrh or after prolonged syringing. In such cases I made Politzer's experiment, while the patient was bending his head forward. Some patients, accustomed to use Politzer's bag at home, resorted to the same expedient on their own accord. I have frequently seen mild and temporary symptoms of irritation to follow the entrance of liquid into the ear during the use of the nasal douche, but severe symptoms only in about half a dozen cases.

In *one* case double-sided acute otorrhœa occurred in the course of *ophthalmo-blennorrhœa neonati.* This coincidence is neither rare nor unknown. I believe that the acute otorrhœa is caused by the cold water running, from the iced compresses applied to the eye, over the cheek into the ear.

In the case noted in our table, I could ascertain the entrance of the cold water into the ear, and, apart from this, there was in the otherwise healthy child, no other cause, of otorrhœa to be found.

Bearing in mind the injurious effect of cold water running into the ear, I warn not only the attendants of children, but all patients who apply cold water to the eyes, lest the water run into the ear. Besides this, I recommend them to put some cotton into the ears.

A similar case was that of a healthy clergyman, æt. 40, who had always had good ears. On July 10th, 1876, four weeks before he came to me, he had suffered intense headache, for which he had his head washed with *alcohol.* A small quantity ran into the right ear, and at once caused in it the sensation of cold and intense pain. The next day serous secretion from the ear set in, and grew gradually thicker. The pain lasted nine days. When he came to me he had ordinary purulent discharge from the ear and a perforation in the membrana tympani, easily recognizable by the mirror and the whistling sound on inflation. He recovered.

The history of this case seems clearly enough to demonstrate that the cold alcohol running into the ear caused first otitis externa, then myringitis, and at last perforative otitis media purulenta. In a similar way various inflammations of the external auditory canal lead to perforation of the membrana tympani and consecutive purulent otitis.

Eczema and *mumps*, also represented in our table, may belong to this category.

One case of *varioloid* produced otitis media acuta, probably by the mediation of naso-pharyngeal catarrh.

Lastly, there are mentioned nineteen cases without any assignable cause, be it that the cause could not be ascertained, or that I had omitted to note it.

Other cases in which perforation of the membrana tympani and otorrhœa set in after injuries, foreign bodies, old plugs of cerumen, and the diverse methods of removing them, further after circumscribed and diffuse otitis externa, have not been included in the table, since in these cases the inflammation of the middle ear was not primary but consecutive.

I do not purpose to dwell on the *whole symptomatology* of acute otitis media, lest this paper be too long. The *grave symptoms*: the external, causing periostitis of the mastoid process and meatus, as well as the internal, denoting the propagation of the inflammation to the cells of the mastoid process and the contents of the cranial cavity, are certainly of such importance that they should be critically reviewed on the basis of exact statistics, both with regard to their prognostic significance and their therapeutic indications. What do the intumescence and tenderness of the mastoid and superior cervical regions signify, and what indications do they furnish? What is the importance of the cerebral symptoms, the headache—which is rarely absent—the vertigo, nausea, vomiting, fainting, somnolence, fever, and the like? The statistics at hand are, however, not extensive enough to discuss these questions conclusively, since only a limited number of the cases were complicated with grave symptoms, but they are large enough to consider some other points, which appear not devoid of interest,

namely, the beginning and duration of the otorrhœa and the termination of the disease.

IV. Beginning and duration of the otorrhœa.

The time of the beginning of the otorrhœa, expressed in days after the action of the cause, or after the appearance of the first pain, is shown in the following table. When both ears were running, only the one was noted in the statistics which first began to discharge:

Ottorhœa began after	1	day in	2	cases.
" " "	2	days in	48	"
" " "	3	"	53	"
" " "	4	"	15	"
" " "	5	"	7	"
" " "	6	"	10	"
" " "	7	"	15	"
" " "	8	"	3	"
" " "	9	"	1	case.
" " "	10	"	3	cases.
" " "	11	"	1	case.
" " "	12	"	1	"
" " "	14	"	7	cases.
" " "	17	"	1	case.
" " "	18	"	1	"
" " "	21	"	1	"

Time not stated in 13 cases.

The table shows, what is generally known, that the discharge from the ear in most cases sets in two or three days after the exposure, *i. e.*, after the beginning of the disease. These typical cases constitute over 50 per cent. of the whole number. The table shows further that the outbreak of the discharge, which coincides with the perforation of the membrana tympani, occurs still frequently enough from the fourth to the seventh day. By adding these cases (150 among 182) we find that in acute purulent otitis media the perforation of the membrana tympani occurs during the first week of the disease in 82 per cent. of the cases. Those in which the suppuration occurs in the second or the third week, may be considered as protracted, as transition forms from acute aural catarrh into acute otorrhœa. Among this category there are certainly many cases that under proper care would not have gone on to perforation of the

membrana tympani. On the other hand, I am convinced that many a case which runs its course from beginning to end as acute aural catarrh, would manifest itself as acute purulent otitis if puncture of the membrana tympani were made. Severe symptoms of irritation, throbbing in the ear, redness and bulging of the membrane, mucous râles on in flation and the like, are cured in many cases without spontaneous or artificial perforation of the drumhead. The recovery in most of these cases is complete, and by no means protracted. Though in such cases the presence of pus in the drum cavity can be diagnosticated with the greatest probability, I have not included them in these statistics which contain only cases of acute *perforative* otitis media.

The duration of the suppuration, *i. e.*, of the purulent discharge from the ear, varied very considerably, as the following table shows:

The discharge lasted:

3	days in 3 cases.	5	weeks in 7 "
5	" 5 "	6	" 9 "
6	" 2 "	7	" 15 "
7	" 8 "	2	months in 13 "
8	" 2 "	2½	" 7 "
9	" 1 case.	3	" 5 "
10	" 5 cases.	4	" 3 "
11	" 1 case.	4½	" 1 case.
12	" 1 "	5	" 1 "
13	" 1 "	6	" 4 cases.
14	" 17 cases.	7	" 2 "
16	" 1 case.	8	" 1 case.
17	" 2 cases.	2	years " 1 case.
18	" 2 "	Unknown or indefinitely long in 52 cases.	
19	" 1 case.	Terminating fatally in 4 cases.	
3	weeks in 20 cases.	Total, 208 cases.	
3½	" 2 "		
4	" 20 "		

The cessation of the otorrhœa does not always coincide with the closure of the perforation in the drum membrane, but precedes it considerably in many cases. Temporary cessation of the otorrhœa was not noted in the table, but only the permanent cure of the discharge.

The fifty-two cases of unknown duration comprise many in which the otorrhœa may have become chronic, but the

majority of them refer to patients who were seen once or a few times only, whose recovery therefore was unknown. In the last table all perforated drum-heads were noted, and this is the reason that here the number of cases exceeds that of patients.

V. Termination and Results.

The *termination* of acute otit. pur. is exhibited in the following table;

Perfect recovery, with good hearing, . .	118	cases, *i. e.*,	64.83	per.	cent.
Discontinued treatment, when convalescent,	14	" "	7.69	"	
Transition into chronic aural catarrh, . .	7	" "	3.85	"	
Transition into chronic otorrhœa, . .	8	" "	4.39	"	
Seen only once, ...	31	" "	17.03	"	
Death, ...	4	" "	2.19	"	
Total	182				

By recovery is meant permanent closure of the membrana tympani and removal of all inflammatory symptoms. Many patients had not yet enjoyed their full acuity of hearing, when the last note of their history was entered, but in many others this stage had been reached. PERMANENT AND COMPLETE CURE IS THE RULE—AT LEAST 80 PER CENT. —IN PRIMARY ACUTE OTITIS MEDIA PURULENTA. This result is demonstrated by the first category of cases, to which the majority of the second and fifth categories are to be added.

The four fatal cases deserve to be specially described.

H. K., a German hotel-keeper, æt. 53, of New York, consulted me on January 14th, 1870. His hearing had been good in both ears until three weeks previously, when, without assignable cause, headache, tinnitus, hardness of hearing, and pain in both ears occurred. Three or four days afterward the right ear began to run. From that time, copious purulent discharge from the ears, pain, occasional loud subjective noises, like the noise of a steamer. I found the patient very much depressed. With the right ear he could not hear the watch at all. Perforation whistle on Politzer's experiment. The mucous membrane of the drum cavity swollen, suppurating freely. In the left ear moderate catarrhal inflammation. Pharynx red and swollen. The severe inflammatory symp-

toms, the throbbing in the ear and copious discharge lasted three weeks. The inner portion of the external meatus was swollen, polypoid granulations were in the drum, the mastoid region was slightly red and swollen, the pulse was accelerated, and the patient complained of violent headache, vertigo, and great debility. I advised him to remain in bed, to put leeches behind his ear, ordered thorough cleansing of the ear and the instillation of an astringent solution. The granulations were removed with the polypus forceps. One day, when the discharge had ceased but the pain continued, I made an incision into the swollen skin of the meatus, and liberated a great quantity of matter. A deep and long incision, according to Wilde, was made over the mastoid process. The improvement began in the fourth week of treatment, *i. e.*, in the seventh of the disease, and progressed regularly in every respect. At the end of February he came to see me. He felt quite comfortable, being free from headache and vertigo. There was scant otorrhœa, but a large perforation of the drum-head, with moderate swelling of the mucous membrane in the drum. The region of the mastoid process was normal. I advised him to be cautious, to cleanse his ear, and present himself every three days.

Two days afterward, I was called to see him, and found his condition very much worse. He told me that, feeling so well on the day he went to me, he had paid visits to several of his business friends, and had taken a glass of liquor here and there. The following night his headache returned with increased violence; he had nausea and vomiting, his skin was hot, and his pulse accelerated. In consultation with his family physician, I ordered six leeches behind his ear, warm water into the ear every two or three hours, and cautious syringing. The cerebral symptoms rapidly increased in severity. When I saw him the next day, I found him apathetic. He had chills, facial paralysis, and was drowsy. The next day, he died in a comatose condition. Autopsy not permitted.

The *second case* was that of a consumptive man, 31 years of age, of New York, whose advanced constitutional disease had been complicated with acute discharge in the right ear two months before I was called to see him. Severe cerebral symptoms were present, but the region of the mastoid process was neither swollen, nor tender on pressure. From this reason, and considering the constitutional disease, I only advised cleansing of the ear with lukewarm water. Patient died a week afterward in a comatose state.

The *third case* was that of a decrepit man, 71 years of age, of

New York, who consulted me, August 24th, 1876, with intense earache and headache, and purulent discharge from the left ear, which had set in four days previously. With this ear he could not hear the watch at all ($h=o$), but understood speech at the distance of one foot ($v=\frac{1}{60}$) During the next three days ,the pain in the head and ear increased, and the walls of the external meatus were swollen ; pulse 120, temperature 99°, great debility. The discharge had ceased. He died on the first of September, eleven days after the beginning of the disease.

The *fourth case* has been described above. It is that of the fatal diphtheria of the pharynx and ear.

VI. Treatment.

In treating acute otitis purulenta, I have laid greater stress on the necessity of *rest* to the patient than is commonly done. Rest, if we want to secure *perfect restoration*, is as indispensable in acute inflammations of small organs as in that of large ones, where, *de facto*, it is a matter of necessity, not of choice. As I strongly advise patients with acute iritis or acute ophthalmoblennorrhœa to remain in bed and take care of nothing but their eyes, in order to recover the full enjoyment of perfect sight, and not expose themselves to the development of permanent synechiæ, opacities, and even the destruction of the visual organ,—in the same way I advise patients suffering from acute otorrhœa to remain in bed and take care of nothing but their ears, in order to reduce the action of the heart to a minimum, keep the whole skin equally warm and in an imperceptible, or, at times, in a low degree of perceptible perspiration. These conditions I consider, essential, if we want to cure an inflammatory affection readily, safely, and completely. As robust patients, are loath to relinquish their accustomed activity when suffering from inflammatory affections of small organs, it is the duty of the physician to call their attention to the consequences and dangers of an *incomplete* recovery. The oculist is commonly more readily obeyed than the aurist and the general practitioner. The practitioner, for instance, is in spite of all admonitions, in many cases unable to keep his gonorrhœa patients at

home and in bed, which precaution, I am inclined to think, would obviate gleet and stricture more effectively than all general and topical remedies together. The more extensive my medical experience grows, the more importance I attach to the establishment of physiological sanitary conditions, in contradistinction to the remedies of the pharmacy, although I am no nihilist. In many cases of the disease under consideration I have most positively observed of what advantage rest, of what disadvantage unrest or imprudence is. Concerning the dangers of imprudence, I beg to recall the above-described case (page 18) of the German hotel-keeper, who, while convalescent from a severe otitis media purulenta, by visiting his friends and taking spirituous liquors, brought about a relapse, which terminated fatally in four days. On the other hand, I found that, when the patients remained at home and took good care of themselves, the perforation of the membrana tympani closed in the shortest time, and complete recovery was obtained. My ophthalmic practice, especially the operative, has forced the conviction upon me that rest in bed is of the greatest advantage in every acute inflammation of some importance. The same principles have guided me in the treatment of acute inflammations of the ear, and I cannot too warmly recommend them. To be sure, acute otorrhœa in otherwise healthy persons may disappear without particular precaution, in the same way as I saw a gentleman recover from a pneumonia which he had contracted in a snow-storm while travelling through the Rocky Mountains, but which did not deter him from continuing his four days' journey to New York. It would, however, be unpardonable if a physician were governed in his directions by such exceptional cases. All aurists warn us of the dangers of neglected otorrhœa, but they mostly dwell only on the necessity of local treatment.

At the head of the treatment of otitis media purulenta I would place the advice to consider the disease as an important and dangerous inflammation, and treat it with as much care and strictness as we treat pneumonia, iritis, and other acute inflammatory diseases. Let us remember only what

the usual and less important consequences of neglected otitis are, viz.: chronic otorrhœa, chronic aural catarrh, thickening of the drum-head, adhesions between the different parts contained within the drum cavity—a life-long misery, which might have been prevented by one week's rest at home and in bed.

How fortunate the result of strict treatment in acute otitis media purulenta may be, and how happy we can make our patients, is exemplified by the following case, which is not taken from the series of those on which this paper is based.

October 25th, 1876, I was consulted by a gentleman residing in one of the most beautiful villas on the Hudson. He had his head wrapped up, suffered great pain, and could only with difficulty understand my speech. He stated that for years he had at times been somewhat hard of hearing, but for two or three days he had been almost completely deaf, and suffered violent pain in both ears. "Doctor," said he "can you cure me in two weeks?" I replied, "I will do my best; but why do you limit me to fourteen days?" "Because," said he, "I have made all arrangements to marry in two weeks, and, leaving these arrangements out of consideration, I would not like to lose much time, for I am sixty years of age." His drum-heads were red and swollen, and he had all the symptoms of acute otitis. Politzer's experiment improved his hearing immediately. I told him to return to his home, go to bed, put four leeches behind each ear, and pour warm water into the ears several times a day. When I went to see him the next day, his pain had subsided, and his right ear discharged. I kept him in bed, ordered thorough cleansing of his ears by gentle and repeated syringing, employed Politzer's experiment, and prescribed an astringent gargle. In the left ear no perforation occurred; the rupture in the right drum-head closed on the fifth day. On the sixth I allowed him to be up. His improvement advanced steadily. On the thirteenth day he paid me a visit. His drum-heads were red in their upper parts only; his acuteness of hearing was $V=\frac{20}{60}$, *i. e.*, speech was understood at the distance of twenty feet. On the evening of the fourteenth day he commenced his wedding journey, which I recommended him to extend not very far beyond the neighboring hills.—Never have I seen a more obedient, and scarcely ever a more grateful patient.

I may be brief with regard to the *local treatment*, since in this I did not materially depart from the customary methods. In the first days, before otorrhœa had set in, I had two to six leeches applied to the ear, filled the ear with warm water several times a day, and ordered an aperient. A number of patients, on their own accord or by advice of their physicians, had applied warm fomentations or poultices to the ear. I have examined these patients with particular attention, and find, in looking over my notes, that they all stated they obtained relief from such applications; I have not been able to convince myself, in any one of those cases, that the wet and warm applications had caused the suppuration to spread. This is heresy, I know, but fact, as far as it goes.

When the discharge suddenly diminished, and, at the same time, the pain in the ear and head returned, I found decided advantage from steaming the ear either with simple or, if the patient preferred, with aromatic water. This caused the ear to discharge again, and relieved the pain. I obtained the happiest results from steaming in some cases in which the cerebral symptoms were so marked that an opening of the mastoid process seemed justified, and I have seen so much benefit derived from this popular mode of treatment that I try it in every case, especially in chronic otorrhœa, in which the discharge suddenly ceases, and pain, vertigo, fever, and other symptoms, together with local inspection, prove that the inflammation has not subsided but rather become more intense. In the majority of cases steaming brings the discharge on again, sometimes attended with the liberation of copious, cheesy, offensive masses. If steaming and leeching do not reduce the inflammation, operative treatment should not be delayed.

The greatest attention was paid, of course, to the condition of the *naso-pharyngeal cavity and the Eustachian tubes.* In recent cases, Priessnitz's applications to the neck were ordered. The naso-pharyngeal cavity was always treated with astringent solutions (nitrate of silver, alum, tannin, sulphate of zinc, etc., one to three per cent.), either in the shape of gargles and nose waters, or by means of a nebu-

lizer or a posterior naves syringe. The use of the nasal douche, however, has been avoided.

In all cases of otitis media that are complicated with swelling of the mucous membrane of the Eustachian tubes, I use astringent injections by means of the catheter. I take care that the quantity of the injected liquid does not exceed a few drops, and compress the bag with moderate force only, so that the liquid exhausts itself in the inner and isthmus portions of the tube, for I have always found that cold liquid entering the drum cavity acted injuriously. Furthermore, I have not yet been able to satisfy myself of the utility of injections of warm liquids, which, at any rate, are only employed in chronic affections of the ear.

Inflation of the ear, either by Politzer's method or with the catheter, was practised in all cases ; its beneficial effect is generally recognized, and Moos (Klinik der Ohrenkrankheiten, page 120) ascribes to Politzer's method even a fundamentally beneficial influence on the closure of the perforations of the drum-head. Though I am convinced of the appropriateness of inflation, I find in my statistics, besides many cases in which inflation according to Politzer immediately improved the hearing, some cases in which, if employed in the initial stage of the disease, it caused pain and temporary diminution of hearing. It is not impossible that the current of air forces mucus and pus from the tube into the drum, and from the drum into the mastoid cells. I am therefore very cautious in inflating the ear during the acute stage of inflammation, and always use the catheter first, together with the auscultation tube. I begin the inflation with slight pressure, increasing it gradually, while I listen through the auscultation tube. By this method one can judge better of the resistances in the tube, and the contents of the drum cavity, than by Politzer's experiment. It frequently happened that the first puffs of air through the catheter produced mucous râles, but then the air entered in a clear and unobstructed stream. The improvement of hearing was in most cases only moderate, but when, immediately afterward, Politzer's experiment was vigorously performed, the acuteness of hearing was considerably increased. I think that every aurist will bear me

out in asserting as the result of my experience, that Politzer's method, in general, produces a greater immediate improvement of the acuteness of hearing than catheterism. If both methods are employed immediately after each other, we should, however, be careful, lest the cumulation of the effect be injurious (Moos). Inflation, in my opinion, is more important in the secondary (catarrhal), than in the acute (suppurative) stage.

I have seldom resorted to the *paracentesis* of the membrana tympani. Though the puncture of the drum-head be a simple and harmless procedure, I use it not without a certain reluctance, probably owing to the poor results commonly obtained by paracentesis of the anterior chamber. I have practised paracentesis of the drum only when the indications (pain, mucous râles, bulging of the membrane, etc.) were clearly pronounced. It afforded relief only when it liberated pus, and was immediately followed by otorrhœa; otherwise it increased the pain, which only subsided when, later on, suppuration set in. Much has been written about the paracentesis of the drum cavity. In the present phase of otology, this operation has become "fashionable," yet there was a time—and it has not long passed by—in which it was declared a sin of omission not to puncture the cornea when hypopyon was present. To-day no oculist performs paracentesis of the anterior chamber for the sake of removing pus, for it is known that pus in the anterior chamber is most rapidly absorbed as soon as its source has been removed. I am loath to apply conclusions by analogy from one organ to the other, but I confess that the present popularity of paracentesis of the drum cavity has not induced me to perform this operation at every opportunity.

Wilde's incision over the mastoid process was often practised, and commonly afforded relief.

Opening of the mastoid process was never resorted to in the series of cases under consideration. Of this operation also I am not a great admirer, and perform it only when the cerebral symptoms are threatening, especially when, at the same time, the secretion has ceased more or less suddenly,

the mastoid region is red, swollen, and tender on pressure *i. e.*, in cases that show some probability of retention of morbid substances in the cells of the mastoid process.

I lay great stress on *careful cleansing* of the ear. This should be done by syringing with lukewarm water, to which a small quantity of table salt or soda may be added. In the later stage, however, the ear canal may be wiped with a cotton plug wound around a dentist's cotton holder, which, if I am not mistaken, Dr. Holcomb, of New York, has introduced into aural practice.

When the discharge continued for some length of time, *weak astringent solutions* were instilled into the ear. If such instillations were made at an early stage, or with stronger solutions, for instance nitrate of silver, 2–5 per cent., they, without exception, increased the inflammation and the pain. I have been led to do this several times, five to ten years ago, when the application of strong remedies to the middle ear was loudly praised on both sides of the Atlantic. I know that these praised applications refer chiefly to chronic otorrhœa, yet I am perhaps not the only physician who was tempted to try them also in the acute stage of suppurative inflammations, where they are, as I have convinced myself, just as inappropriate as in the primary stage of inflammation of the conjunctiva.

Polypoid granulations were several times observed to form in the course of acute otitis media purulenta, but scarcely ever required operative treatment. If the ear is thorougly cleansed, and the mucous membrane of the naso-pharyngeal and tympanic cavities rationally treated, granulations in the tympanic cavity, when formed during acute inflammations, commonly disappear.

Collections of matter in the walls of the meatus and the surroundings of the ear, were noticed in several instances, and without delay removed by incisions.

ON THE FORMATION OF SEQUESTRA IN THE MASTOID PROCESS OF THE CHILD.

By DR. ARTHUR HARTMANN, of Berlin.

Translated by Dr. James A. Spalding, Portland, Maine.

ANATOMY.

THE anatomical relations of the mastoid process in new-born children, and in the earliest years of life, have been most clearly described in the valuable works of Schwartze and Eysell,* and by Wildermuth.† The cavity which develops itself later into an air-containing system of cells in the mastoid process, and to which Wildermuth, very pertinently, gives the special name of antrum petrosum, is even in new-born children of considerable size, and exhibits the shape of a triangular pyramid (Schwartze), one of whose surfaces, directed upward, is formed by the continuation of the roof of the tympanum. According to Schwartze, the cavity is 8 *mm.* long, 7 *mm.* high; according to Wildermuth, 9 *mm.* long, 5 *mm.* high. The antrum changes in the earliest years of life, in that it increases in size, and undergoes a change in shape. Its form by this time resembles that of a nine-pin, with its base turned upward (Wildermuth), whose height measures 8–9 *mm.*, and the length of its base 1 *cm.* (towards the end of the first year of life). The increase in volume of the antrum petrosum takes place, not only through the growth of all the osseous parts enclosing the cavity, but also through an absorption of the walls from the inner

* Ueber die künstliche Eröffnung des Warzenfortsatzes. Archiv für Ohrenheilk. Band VII.

† Die lufthaltigen Nebenräume des Mittelohres beim Menschen. Zeitschrift f. Anat. u. Entwickelungsgesch. Band II.

surface outward, which occurs especially in a downward and backward direction. I have already called attention to the fact, that in twenty-one sections of the temporal bone in children, I found the average thickness of the bony wall between the antrum and the posterior fossa of the cranium to be 4 *mm.*, while in twelve temporal bones of children, at the age of 1–5, the antrum was separated from the posterior fossa of the cranium by a bony wall that averaged but 2 *mm.* in thickness, and in five cases by a bony lamella that was scarcely 1 *mm.* thick. Basing my opinion upon these measurements, I expressed myself thus, as regards the origin of the cells: "Since the cavity is again found smaller in later years, this can only happen by a narrowing from the sides, that is to say, by an encroachment of the partition walls of the cells."* The first trace of the formation of the air-containing cells is found in the newly-born; on the one hand, small ridges arising above the surface, show themselves at the posterior and upper angle of the antrum, which is formed by the petrous bone; and on the other hand, at the anterior and outer surface, which belongs to the squamous portion, and which, at the latter part, frequently show a fan-shaped arrangement. In the course of their further development, it is especially those ridges projecting from the squamous portion, and bound together by a lattice-work which encroaches upon the cavity, and finally unite in a fan-shaped arrangement with the opposite wall of the petrous bone. From a larger series, now lying before me, of sections through the mastoid process of the temporal bones of children, especially during the third, fourth, and fifth years of life, there is found, depending upon the age, only a framework of close meshes on the squamous portion, which is united with the petrous bone with scarcely any mesh work, and then again, in older children, the bonds of union are much more numerous, and there is frequently no fan-like arrangement. While at first, there is still an empty cavity, which extends from its opening into the tympanum to the posterior wall of the antrum, at a

* Ueber die Perforation des Warzenfortsatzes; v. Langenbeck's Archiv.; Bd. XXI.

later stage it is first divided longitudinally by the development of a bony framework into several compartments, then by further division, and by the development of partition walls in an oblique direction, the air containing spaces of the mastoid process of adults are originated. Together with the development of the framework, there is, besides, a simultaneous enlargement of the collective space of the cavity, especially towards the mastoid process, which develops itself from the time of birth onward, by a conversion of the cancellous bone into air-cavities. Of the original cavity, standing in direct union with the tympanum, there remains only the part designated as the antrum mastoideum, which communicates with the tympanum by the approach to the antrum mastoideum. In spite of the great variations shown in isolated preparations from individuals of the same period of life, we are able, by comparing a large number of specimens, to demonstrate the process of development as just described.

The air-cells of the mastoid process, and especially those which lie behind and below it, open into the antrum mastoideum of adults, while those situated sideways open also in part towards the antrum, or directly into the entrance to it. In many cases also in adults, we can demonstrate the radiating arrangement of the cells, to which Schwartze and Eysell first directed attention, since we find nine-pin shaped spaces, the points of which are directed towards the antrum mastoideum, that is towards its entrance and towards the tympanum.

While according to the common opinion the development of these cell-cavities takes place in this way, viz., that up to the time of puberty the cancellous bone undergoes rarefaction, after which only the partition walls of the cells remain, I became convinced by the results of my measurements that this sort of cell-development plays a subordinate *rôle*, since the collective space of the cavity first enlarges itself, and then the cell-system develops itself by the new formation of partition walls. If the growth of the cells did not take place, the original cavity must likewise undergo an increase of volume, just as the capacity of the cranium becomes enlarged by the growth of its bony capsule. There are

great variations to be found in individuals; if either the one or the other process has remained in a backward state, at one time there is a preponderance of the enlargement of the collective space of the cavity, and then again of the development of the framework, enclosing the pneumatic spaces.

I was able, by the results of my measurements, to convince myself as already mentioned, that this process of development just described must take place, since I found that the expansion of the antrum petrosum, was subsequently developed into the cell-system, so considerable in new-born children, and in the first years of life, that it was equal, not only relatively, but even absolutely, to the size of the antrum mastoideum in adults, and in many cases even surpassed it. Later there must be a diminution, which could take place only by a formation of cells from the walls. Moreover, this mode of development seemed to me very probable, since in isolated cases in adults I found the lateral wall of the antrum mastoideum formed by osseous plates, which showed no openings from cells, since the cells situated at the side did not open towards the antrum, but towards the approach and the tympanum. In these cases there could be no question of an extension (in the shape of diverticula) of the mucous membrane from the antrum as middle point. In that case I have already called attention to the fact, that the larger pneumatic cavities of the mastoid process do not communicate directly with the antrum mastoideum, but only by small openings with the neighboring cellular spaces, which seems to me to be against a development starting out from a previously formed antrum.

The petro-squamous suture runs longitudinally through the middle of the roof of the original antrum petrosum, and extends backward and outward to the incisura parietalis; from that it closes as the mastoideo-squamous suture upon the outer surface of the mastoid process, runs from in front downward to the posterior wall of the auditory meatus, and from here returns upward again to the tympanum. The pyramid is thus separated from the squamous portion of the temporal bone, and can be easily separated in the macerated temporal bones of new-born children. The

ossification of the suture makes rapid advances even in the course of the first years of life, and the mastoideo-squamous suture especially, is found completely ossified at a very early period. While the petro-squamous suture always shows traces of itself on the floor of the middle cranial fossa, and is easy to recognize even at advanced periods of life, there are no traces whatever of the mastoideo-squamous suture in the majority of cases of older individuals. It is only exceptionally that we find a few grooves and furrows on the outer surface of the mastoid process, which have remained as vestiges of the former suture (Gruber).

PATHOLOGICAL ANATOMY.

The arrangement and nature of the cell-cavities, as well as the relation of the sutures in the mastoid process of the child, play an important *rôle* in a practical point of view. The inflammatory process spreads from the tympanum and antrum petrosum to the neighboring regions, much more easily before the ossification, especially of the petro-squamous suture, than at a later period of life. There are cases in which meningitic symptoms arise in a new-born child, a few days after the appearance of an otorrhœa, and end fatally. The older the child, the less is the danger of the consecutive cerebral affection. Toynbee rightly calls attention to the fact, that up to the second or third year of life, the cerebrum is most frequently affected, corresponding to the anatomical relations, while affections of the cerebellum and of the transverse sinus appear only at a later age.

The secretions, however, which collect in the antrum, gain an exit to the outer surface much more frequently than to the interior of the skull, since they lead to destruction, or chipping of the external wall by necrosis, and to the formation of abscess under the investing skin. The universal opinion is that the preformed paths, and the boundaries for these processes, are especially constituted by the sutures, since it is assumed, that the secretions escape outward through the sutures, and that the processes of necrosis are bounded by them. Bezold,* especially, speaks most in

* Erkrankungen des Warzentheiles. Archiv. f. Ohrenheilkunde. Bd. XIII.

detail upon this method of propagation of the morbid process, since he assumes, that when the formation of abscess behind the ear ensues in the course of purulent inflammation of the tympanum, lasting for months or years, the collection of secretion in the antrum makes its exit along the mastoideo-squamous suture. Although this may be more frequently the path, especially in the first years of life, I could not help believing, after more accurate examination of a large number of macerated temporal bones at the age of childhood, that the way through the squamous portion is really much nearer and more favorable than through the mastoideo-squamous suture. I have, on the one hand, just called attention to the fact that the ossification of the suture comes on, as a rule, at a very early age; on the other hand, the cells of the squamous portion, for the most part, approach very near the surface, so that from here the propagation of the inflammatory process could follow more easily than through the suture. Practical experience shows that, when the abscess which has formed behind and beneath the auricle, is incised, there are, as a rule, already present, sometimes larger and sometimes smaller, openings into the outer wall of the antrum. It is not possible to decide from the observations and experiences before us, whether or not the mastoideo-squamous suture plays an important part in the origination of these openings. If we syringe through such an opening, the fluid escapes by the external auditory meatus. Still rarer are those instances where such a communication is not present, in which case we may suspect that we have to do with a periostitis of the external surface of the bone, without direct transmission from the antrum outward.

Thus, in the course of a very violent purulent inflammation of the middle ear after scarlet fever, I saw the formation of an abscess behind the ear of a boy four years old. When I made the incision, the surface of the mastoid process was found to be separated for a considerable extent from its periosteum. There was no communication with the antrum and the tympanum. A drainage tube was inserted. It was removed on the second day, and the antiseptic bandage applied. The walls of the abscess had again united by first intention, and a perfect cure soon followed.

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It may happen, moreover, that the abscess has originally a communication with the middle ear, which again closes. The following case, which lately came under my care, might be reckoned in this class:

This was the case of a boy three years old, who, when six months old, without any other disease, had an otorrhœa in his right ear; at the age of eighteen months, an abscess formed behind the ear, which, however, did not open outward, but probably through the antrum towards the tympanum, since one day, when the growth behind his ear decreased in size, a large amount of pus suddenly escaped from the external auditory meatus. Fistulous openings outward formed themselves later behind the auricle, through which a secretion discharged constantly, although sparely; the secretion from the external meatus was slight. After chloroform had been administered, I made an incision at the insertion of the auricle, at which point one of the two fistulæ was. This incision was joined to the second fistulous opening, lying further behind, by an incision made perpendicular to the first. The surface of the mastoid process showed itself to be carious, and small carious patches reaching to the depth of ½ *cm.* were removed with the sharp spoon. As the bone showed itself healthy at a greater depth, nothing further was done in the way of digging deeper. In the course of the cure, some small osseous particles were thrown off; perfect cicatrization occurred.

When those particles of bone are thrown off by necrosis, we cannot precisely say from the examination of the contours of the sequestrum, from which part of the original bone it is formed, nor whether its expanse is bounded by one of the sutures or not. Two sequestra in my collection go to prove that the line of demarcation does not always coincide with the suture. I extracted these specimens from a child, the course of whose disease will be described more in detail under Case No. 3. In both sequestra which belonged to the roof of the antrum, the complete ossification of the petro-squamous suture is demonstrable, so that indeed the suture has played no *rôle* in the propagation of the process.

The inner portion of the mastoid process, especially the distribution of the cells, seems to have greater influence than the sutures upon the development and expansion of

the diseases of the bones. The inflammations of the middle ear, so frequent in childhood, extend also as a rule upon the mastoid process, and may here give rise to diseases of the bone. Although indeed the hidden situation of the antrum favors on the whole the deposition and collection of secretions, and the advent of processes of decomposition, this is still more the case by the small air-cavities in the antrum. While in adults the larger cell-cavities as a rule are protected against a direct transmission of the inflammatory process to the mucous membrane, since, as we have seen, they do not communicate directly, but by small openings with the neighboring cells, and these again in the same way with the antrum, the inflammatory process in children can encroach directly upon the lining membrane of these cavities, which are still in process of development. Hence caries and necrosis in the mastoid process frequently ensues, and especially of the framework which projects from the squamous portion of the surface of the mastoid process towards the cavity, and which has the finest mesh-work in that part which is turned towards the outer surface.

SYMPTOMS AND COURSE.

The cases of carious processes and formation of sequestra in the mastoid process of children, a great number of which have come under my care, had this in common, that large masses of purulent secretion were removed from the external auditory meatus. In most cases this secretion lasted for months or years, began usually without violent inflammatory processes, slight at first, and gradually growing more considerable. While the secretion at first had a muco-purulent character, it acquired later the real purulent, offensive nature. It consequently seems that this is the usual process; the mucous membrane covering the cell-spaces is destroyed by the decomposition of the secretion produced, caries develops itself, and necrosis follows, for sometimes smaller, and now again larger portions of the mastoid process are chipped off. Precisely the framework of the cells most frequently becomes necrotic, and either smaller sequestra are formed, which can be thrown off through the external meatus, or they are of more considerable size, embracing the whole

thickness of the wall of the antrum, since they extend as far as the outer surface to the auditory meatus, or to the lower surface of the cranium; these sequestra can be removed only by an operation. Granulations appear with the formation of the sequestra, and in their turn give rise to an increase of the secretion. The sequestrum may be pressed by the granulations towards the tympanum, and from there urged outward (an occurrence to which Bezold has especially called attention). The bottom of the external auditory meatus is found as a rule filled with granulations; if these are removed, the exit of the sequestrum is facilitated, or it can be removed artificially. In how far resorption can ensue, especially in the case of small sequestra which are imbedded in the granulations, remains undecided.

During the course of the disease an abscess frequently forms behind the auricle, which is pushed forward and outward, and fluctuation is soon discoverable. The swelling may become very considerable, extending upward to the surface of the squamous portion, backward to the occiput, and downward along the side of the neck. It happens sometimes that the abscess evacuates itself inwards, resp. through the external auditory meatus; if this is not the case, it opens outward, unless we interfere operatively. When the incision is made the periosteum is found lifted for a considerable expanse from the underlying bone, and sometimes granulations have pushed themselves between the skin and bone, especially when the process has lasted a long time. The probe almost always shows an opening of varying circumference leading into the antrum. If this opening is enlarged with the sharp spoon or chisel, the antrum is found, filled with granulations, beneath which lies carious bone, or one or more sequestra are imbedded.

The origin of the formation of abscess behind the ear is in most cases caused by the hindrance of the flow of the secretion from the ext. aud. meat., since the granulations plug the inner end of the meatus, and the secretion accumulates in the antrum. As a result of the carious destruction which has already ensued in the course of the

disease, and which most frequently affects directly the external wall of the antrum, the purulent collection may propagate itself towards the outer surface, here cause inflammation and lead to extensive detachment of the periosteum from the underlying surface of the bone.

CASES.

The following cases may serve to illustrate the various incidents of the disease:

First Case.—Purulent otorrhœa lasting for 1¼ years. Formation of abscess behind the right ear; removal of a large sequestrum: Cure.

Since I have already described this case,* I confine myself to drawing attention to the important points, in reference to the morbid processes just depicted.

After a girl, 3 years old, had suffered for more than a year from a very abundant and offensive discharge from the right ear, an extensive formation of pus ensued behind the auricle, with a violent inflammation of the surrounding tissue. Slight pressure upon the abscess evacuated its contents through the external auditory meatus, and the cavity could be cleansed by syringing into the meatus. On account of a sequestrum which was found in the tympanum, an operation was decided upon, after the inflammatory symptoms had abated. The operation could not be finished on account of dangerous narcosis from chloroform, and only an incision was made at the insertion line of the auricle.

The surface of the squamous portion was found denuded of periosteum at a spot as large as a cent, and was covered with dirty-looking granulations which were removed with the sharp spoon. When the operation was repeated, the skin seemed again united with the underlying bone. The opening in the bone was enlarged with the sharp spoon. The track of the incision was enlarged upward and downward by a curved sound pushed forward into the tympanum, so that the auricle could be drawn off and forward from its base, and the sequestrum felt with the tip of the finger in the tympanum. Since the surface of the antrum as far as the tympanum was found to be destroyed, the removal of the sequestrum after a vain attempt with the forceps, was accomplished

* Entfernung eines grossen Sequesters aus der Paukenhöhle eines Kindes Von Dr. A. Hartmann, *Deutsche Med. Wochenschrift*, No. 43, 1877.

with the sharp spoon, by means of which it was pried out, without especial difficulty. It had a triangular pyramidal shape; its greatest length being 13 *mms.*, height and breath 10 *mms.* After the wound had been kept open by drainage tubes for three weeks, and two small sequestra which were loosened with the sound had been removed, a cure followed in five weeks after the operation.

The auricle required about the same position as upon the healthy side, and the secretion which had been so considerable before the operation, ceased completely. At present I see the child every three months, and find it necessary to remove with the syringe and probe a few thickened membranous masses, from the tympanum.

Second Case.—Formation of sequestra in the left mastoid process: Operation. Death six weeks after the operation.

Arthur Mohn, 1½ years old, came under my care April 27th, 1878. His parents were healthy, but an older brother suffered from a scrofulous disease. The history of the case shows that an otorrhœa began in the left ear at the age of six months, after the child had appeared restless for a few days, but without more violent inflammatory symptoms. The discharge from the ear was from the first very abundant, now somewhat less, again greater; always yellow, purulent and offensive. A keratitis began simultaneously with the discharge from the ear, healed, and left an extensive cloudiness of the cornea, and moreover, the retro-maxillary glands had been sometimes swollen.

The examination of April 27th showed the patient of pallid skin, moderately fat; bodily functions normal. There was an offensive serous discharge from the left external meatus, after the removal of which, granulations were seen at the bottom the meatus which completely filled it. A larger part of these were at once removed by the snare, and a further amount on the next day. The region of the mastoid process behind the ear was painful on pressure, and slightly reddened.

The inflammation extended over the mastoid process during the next few days, in spite of the removal of the granulations in the external meatus; the swelling became more considerable, and the auricle was pressed a little forward and outward. Fluctuation appeared on May 2nd, so that an incision was made. A coffee-spoonful of thick offensive pus at once flowed out. When the solution of carbolic acid was syringed into the opening made by the incision, it flowed out from the ext. meatus. A drainage tube

was put into the opening. Rough bone was felt in the mastoid process with the probe, but its mobility could not be demonstrated. The subsequent treatment consisted in regular cleansing with a weak solution of carbolic acid, and granulations in the ext. meatus which formed again and again, had repeatedly to be removed. While the swelling behind the ear diminished quickly, there was still an abundant, purulent secretion, especially from the wound. In the second week in June, swelling appeared in front of the external ear, since the tragus, and the anterior region of the ear began to inflame, and the skin became red, hot, and tense. On account of the approach of these new complications, I found myself com pelled to take the child into the Moabit barrack hospital.

June 18th, under chloroform, the fistulous opening originating from the previous incision was enlarged upwards and downward by incisions in the insertion line of the auricle, the edges of the wound were held apart with sharp hooks. After the hemorrhage had been stopped, the outer wall of the antrum petrosum was found to be perforated by an opening as large as a bean, and behind it were granulations. The softened edge of the opening was enlarged with the sharp spoon, which was accomplished without using force. The granulations were scraped out, together with a few particles of necrosed bone. Since the hemorrhage was very slight, the field of operation could be continually kept clearly in sight. I could see in the lower part of the antrum, a considerable piece of bone, which on pressure with the sound showed itself slightly movable, and could then be pried out with a sharp spoon, and removed with the pincers. A thick drainage tube was laid into the wound which was covered with salicylic wadding. The sequestrum which had been removed, and which consisted of porous bone soaked through with purulent and partly thickened secretion, measured 10 *mm.* on its longest side, while its greatest breadth was 9 *mm.*, and its thickness 5 *mm.* Since the operation had been free from all complications, and the comparatively slight interference could be made in the most careful way with a full view of the parts, and without the use of force, I believed that there could be no doubt of a favorable result.

The after treatment consisted in removal of the bandage twice daily, and syringing with a two per cent. solution of carbolic acid. On the second day after the operation, the temperature first began to increase: Evening 38.4 (Cent.), on the third day 37.8, fourth day 38.2, while on the following days it returned to normal. The

secretion after the operation was decidedly less, the wound began to grow clean, and granulations to form. Two small sequestra could be loosened with the probe, and were removed with the syringe. On the ninth day after the operation, diarrhœa set in together with loss of appetite and increase of feverishness to 39.0 at evening, which repeated itself on the following days to 39.6, with a return to normal every morning. The wound began to look unhealthy with the return of feverishness, and the region around the wound grew red and moderately swollen. A small abcess formed close behind the ear in the following day; it was incised, and a second one followed on the side of the neck which likewise had to be opened. The temperature became normal, when this inflammation decreased. The neighborhood of the wound remained slightly reddened, and the track of the wound showed no tendency to heal. Diarrhœa and loss of appetite continued, and were but slightly improved by the most careful nourishment and the medicines exhibited.

July 19th, the patient was discharged from the hospital, at the wish of his parents. A relapse followed after temporary improvement of the symptoms on the part of the digestive organs.

On the evening of July 28th, convulsions followed, and from the exact account of the parents, only of the right side of the body, since both the little arm and the leg fell into clonic convulsions. On that night and the following day convulsions appeared in the rest of the body. Death in a comatose state.

The section was not allowed, and I could only convince myself with the probe that there was no communication from the cavity in the mastoid process towards the interior of the cranium.

REMARKS.

It is difficult to decide how it happened in spite of the very favorable course of the operation itself, and the antiseptic after-treatment, that the result was fatal. Since we were obliged to operate during the inflammatory stage, it seems probable to me that just as the resorption of inflammatory products had occasioned the formation of abscess in the neck, and also the subsequent fever, by this same process inflammatory deposits in the cranial cavity were produced, and were the cause of the fatal result. It seems to me that local depositions must have taken place on account of the appearance of unilateral convulsions which pre-

ceded death. Unfortunately this view could not be proved by an autopsy.

Third Case.—Formation of numerous sequestra on both sides, especially from the roof of the tympanum and the antrum petrosum; death eight months after the operation; abscess of the brain.

Paul Braun, æt. 2, came under my care December 1st, 1877. The father suffers from chronic bronchial catarrh, with a phthisical appearance; the mother is healthy. The father carries on his trade of cigar-making in the common family sitting-room. The patient, as we learn, recovered from an inflammation of the lungs at the age of six months. The discharge from both ears began at the age of 1¼ years, without any especial inflammatory symptoms; the secretion was purulent from the first, now less, now more abundant, never ceasing entirely, and always offensive. The child was poorly developed since birth. Its nights were very restless; it usually took no interest in things going on, made no attempts to walk, but had always a good appetite. It had been treated previously with instillations of zinc-solution. Four weeks before the child came under my care, the parents noticed for the first time behind the left ear a swelling which enlarged slowly.

Present state.—The child has a sickly appearance, the skin is flabby and anæmic, the superficial veins, especially on the neck, are very full, and of a bluish look; meagreness of flesh. There is a very extensive secretion from both ears, of dirty yellow, offensive pus, after the removal of which granulations are seen at the bottom of the external auditory meatus. While the neighborhood of the right auricle is sound, there is a swelling as large as a dollar behind the left ear, without inflammatory appearances on the skin which covers it, and there is a spot of fluctuation close behind the ear. This is incised, when but slight discharge follows; the fluid syringed in flows from the meatus, and towards the nose; the sound touches rough and seemingly movable pieces of bone. The granulations which grow luxuriantly from the tympana towards the external meatus are removed with the snare. Dec. 11th, on syringing, a small sequestrum is removed from the right ear. The secretion continues very excessive, so that a thick bandage, morning and evening, is wet through.

In spite of the unfavorable bodily health of the child, I made up my mind, although there seemed to be but very slight hope of

success, to check the excessive secretion by removing the sequestrum, and so to bring the child into a better state of development. For this purpose I had him transfered to the Moabit Hospital. December 16th, under chloroform, the opening already existing on the left side was enlarged upward and downward, and the dirty-looking granulations under the skin were removed with the sharp spoon. The outer wall of the antrum was found extensively destroyed, and several smaller particles of bone, together with the granulations in which they were imbedded, were removed from the antrum. The incision-wound was kept open by a thick drainage tube; salicylic bandage; syringing twice a day with a two per cent. solution of carbolic acid. The canal of the wound, kept open by the drainage tube, was so wide, that when the tube was removed, the antrum could be nicely overlooked with the reflector, and in the following days, under control of the eye, a few more small sequestra could be loosened with the sound and extracted. December 23d, a large sequestrum was removed in this way with the bent forceps, and on December 25th, a second of about the same dimensions. The first was 15 *mm.* long, its greatest breadth 10 *mm.*, and its thickness 5 *mm.*; its form was very irregular. The second sequestrum represented a thin plate, the roof of the antrum; its greatest length, 15 *mm.*; greatest breadth, 9 *mm.* The upper surface appeared smooth, and the suture, corresponding to the petro-squamous fissure, ran along it longitudinally. The surface of the sequestrum turned towards the cavity of the cranium, was covered with pus and small scales of thickened, cheesy secretion, so that a purulent process must have existed for a long time previously, between the dura mater and the bony substance of a part of the middle cranial fossa.

While the secretion in the left ear decreased after the removal of the sequestrum, it continued in the right with its former intensity. The neighborhood of the right ear appeared healthy, only the region close behind the ext. aud. meat. felt somewhat swollen, and somewhat softer than the rest of the neighborhood. As I suspected here also the formation of a sequestrum, an incision 2–3 *cm.* long was made, December 26th, under chloroform, at the insertion-line of the auricle, when the external wall of the antrum was found destroyed, and its cavity filled with granulations. After careful removal of the granulations, and a few small particles of bone, a large sequestrum was extracted, measuring 23 *mm.* long, 13 *mm.* wide, 8 *mm.* thick. Its upper surface was smooth; the

petro-squamous suture likewise ran along its longest side; moreover, the sequestrum consisted of the outer and upper angle of the antrum petrosum, and here also were found those sinuosities, corresponding to the spaces which later become pneumatic. January 15th, 1878, a small piece of bone could again be removed with the pincers, and on January 23d, a second somewhat larger piece, for the extraction of which the canal of the wound, which had already narrowed, had to be enlarged by an incision.

The secretion on both sides had become considerably less, in comparison with that before the operation, but we did not succeed in removing the offensive odor, although the ears were syringed twice daily with a solution of carbolic acid. There was no increase of temperature after these various interferences. The general health began to improve; so much so, that the boy gained more than two pounds in weight during his stay in the hospital, until the beginning of May. While the incisions were still kept open, granulations developed themselves far back, especially in the tympanum, and growing luxuriantly into the meatus, had to be touched repeatedly with Arg. nitr. and chromic acid. Although rough bone could still be felt on both sides, I finally let the canal of the wounds close so far, that only the point of the syringe could be just pushed through, and a regular cleansing gained. In spite of the continuous, although diminished, suppuration, the patient was discharged from the hospital in the beginning of May. The boy had grown so strong that he made attempts to walk, but did not trouble himself much, or at all, with what was going on around him.

Deterioration soon set in, with repeated diarrhœas; a catarrh closed the nose, and caused eczema at the nostrils; the boy began to grow weak again, so that I admitted him once more into the hospital on June 26th, 1878. The secretion from both ears had again become abundant, rough bone could still be felt on both sides with the sound, but on the left side only did one bit of bone appear movable. The main stress in treatment was laid as before, upon an improvement in the state of the system. The left fistulous opening was enlarged, and a small sequestrum extracted. All attempts to improve the bodily health failed; diarrhœa set in, with decreased appetite. On July 15th, after the patient, as the nurse said, on the evening before had presented no striking symptoms, death followed with general convulsions.

Autopsy:—After the cranium had been opened the surface of

the brain was found to be very pale, the sinuses bloodless, and plugged here and there with small coagula. After the brain had been removed, there was found on the left side at the floor of the middle cranial fossa, and in the region just over the labyrinth, a spot as large as a bean, covered with soft granulations, and its neighborhood was tinted a sort of dirty red ; the same tint was also found on the right side, upon the dura mater which covers the tympanum, and its nearest surroundings. When water was injected from the meatus into the tympana, the dura mater on both sides was lifted up as far as the middle of both petrous pyramids, and a thin stream of water flowed, on the left side, through the above mentioned granulations. A discolored spot, as large as a cent, was found on the under surface of the temporal lobe of the brain, corresponding to that spot in the dura mater which was covered with granulations ; there was no purulent deposit nor infiltration, and these were also absent from the remaining surface of the dura mater and the periphery of the brain. When the brain was pressed even slightly, greenish yellow pus escaped suddenly from the discolored spot, and an incision revealed an abcess cavity as large as a walnut, in the left temporal lobe, with a capsule about 3 *mm.* thick, which showed firmer consistence than the surrounding brain-substance.

As the body could not be disfigured, the two temporal bones only were removed. Since the relations on both sides were very nearly similar, it seemed judicious to subject both preparations to a common examination. After the skin was removed, openings as large as a pencil were found a little above the meatus, and leading into the enlarged cavities of the mastoid process. The region of the tympana, and the cavities of the mastoid process were further opened by splitting the dura mater which covered them. All the signs of extreme destruction on both sides were now seen. The posterior-upper wall of the aud. meat. was absent both right and left, and on both sides the roof of the tympanum. *Left:* the necrosis of the posterior wall of the antrum was already circumscribed, and the sequestrum, not yet loosened, appeared on the posterior surface of the pyramid, well defined towards the neighborhood, to the extent of 1 *cm.* in its various dimensions. Moreover, the wall of the left bony tube was carious in its whole extent, the thin plate between the carotid and the canal of the tube was necrosed, and the outer wall of the carotid covered with pus. *Right:* A piece of the squamous portion as large as a bean above the meatus had been attacked with necrosis, and the bony canal

of the tube was also carious in its whole extent. The tympana and the cavities of the mastoid process were covered with a swollen mucous membrane, more than 1 *mm.* thick, which at several spots, especially at the tympana, showed polypoid growths. On the left side the covering was absent only at the posterior wall of the antrum, where the bone lay bare, and also where it crossed over to the dura mater. Extensive purulent secretion was found between the dura mater and the temporal bone, and particularly on the left side the whole angle of the temporal bone from its outer end to the height of the porous acust. int. was surrounded with pus, and also the posterior surface of the temporal bone in its outer half, backward and downward to the suture with the occiput, was covered with pus. A layer of pus was also on the upper surface, encroaching over the labyrinth, and outward upon the squamous portion. The deposit of pus extended nearly as far on the right side as on the left, since the posterior and upper surface of the right pyramid was surrounded with pus, which however did not reach so far towards the middle line as in the left side. The nerves running into both meat. audit. int., were perfectly normal, and the wall of the labyrinth-capsule turned towards the tympanum did not seem to have been attacked by the destructive process. This wall was covered with a thickly covered mucous membrane, beset with granulations. It therefore seemed probable that the contents of the labyrinth were not involved. However, an opening of the labyrinth was not undertaken. We have to notice as regards the autopsy of the rest of the body, that a cavity as large as a walnut was found in the right upper lobe of the lungs.

REMARKS.

While the abundant secretion of pus, the offensive odor which could not be obviated, and the spontaneous evacuation of a small sequestrum, lead us to imagine the formation of sequestra before the operation, yet there were no points of support for the assumption that such an extensive destruction was present. Had we suspected it, the operative interference would have been spared, as purposeless. It is impossible to decide how early the abscess of the brain had developed itself, or whether it was already present before the operation or not. A question which arises after the result of the autopsy is this: Was the extensive detach-

ment of the dura mater from the surface of the pyramid produced artificially, or did it indeed exist before the operation? It seems to me just possible that after a portion of the surface of the pyramid fell away when the sequestrum was removed, the syringings loosened the dura mater from its basis, and thus allowed the extension of the suppuration between the dura mater and the bone. I believe, however, that I may deny this possibility, since on the one hand such a separation seems improbable, considering the antagonistic pressure of the brain, and on the other hand, the cleansing of the incisions was always undertaken most carefully, and without the application of force, usually with a small ball-syringe, and with a larger syringe only when I did it myself. Hereafter it might indeed be recommended in such cases to use the syringe carefully.

The enormous extent of the destructive process, to say nothing of the unfavorable bodily state of the patient, prevented a cure in this case.

I desire here to mention still a *fourth case*, in which I lately had an opportunity of operating, although the cure is not yet complete.

M. S., 2¼ years old, was received into the Moabit hospital October 1st, 1878. His mother has suffered from a cough and pain in the breast after violent exertion. The brothers and sisters are sickly and weak. The patient was a healthy child from the time of his birth, and was suckled until he was 1¼ years old. When he was nine months old a purulent discharge appeared in the right ear, and has lasted uninterruptedly ever since, sometimes slight, sometimes abundant. Inflammation began behind the right ear, about four months ago, and led to the formation of an abscess, which the mother opened with a needle, when a large amount of offensive pus was discharged. The opening thus formed did not heal, and an offensive discharge continued. The patient is said to have had an inflammation of the lungs four months ago, since which he has had a cough, which has grown violent during the last fortnight.

Present state.—The patient is very poorly developed for his age, and is moderately well nourished. He has not yet learned to walk; he cannot speak a word, but his intelligence seems not to have suffered. His hearing is preserved in the left ear at least.

His face is pale, and the mucous membranes are anæmic. Dry bronchial râles can be heard on the breast. There is a purulent and offensive discharge from the right auditory meatus. The auricle is pushed forward, the region behind it is swollen, the skin is reddened, but there are no signs of recent inflammation. There is a fistulous opening 1 *cm.* behind and beneath the auricle, from which also extremely offensive pus flows. On probing at a depth of 3 *cm.* forward and upward, we touch rough and movable bone. The external auditory meatus is narrowed, and the bottom is full of coarse granulations. When a liquid is syringed into the fistulous opening, only a slight quantity escapes from the external meatus.

October 7th, after the patient had been chloroformed, I made an incision from the fistulous opening upward to the insertion of the auricle, and through the whole thickness of the swelling behind the external ear. The incision was made 3 *cm.* long, so that the auricle could easily be drawn forward with the sharp hook, and a free view gained into the cavity in the bone, which was filled with granulations. An arterial hemorrhage was stilled with the fixation-forceps. After the granulations were removed with the sharp spoon, a perfectly loose sequestrum was found in the bottom, and easily removed with a narrow spoon. The surface of the antrum petrosum was wholly destroyed as far as the tympanum, so that no more bony bridges were present between the cavity laid open by the incision and the external meatus, and the sound introduced into the external auditory meatus from the incision was visible at the bottom. The sequestrum removed, consisting of porous bone, was 14 *mm.* long, 8 *mm.* wide, 7 *mm.* thick. After its removal, a spot of bone as large as a lentil, and deprived of its periosteum, was found only at the outer end of the upper wall of the cavity. A thick drainage tube was inserted, and the after-treatment was antiseptic.

The temperature increased on the second evening only after the operation to 38.2, otherwise it remained normal. The secretion became normal after the operation, and lost its offensive character completely. October 15th, the general condition is good, leaving aside the somewhat diminished appetite, and the wound is beginning to fill up with healthy granulations.

REMARKS.

In this case also, as in Case 1, it was the surface of the squamous portion beneath the auricle, together with the

framework below, which was found to be destoyed and forming the sequestrum. Considering the size of the sequestrum, in this case also, as in the previous cases, it was impossible to think of a resorption or spontaneous expulsion through the external auditory meatus, and we had to resort to extraction. As the operation was undertaken during a perfect reactionless stage of the process, and the surface of the wound since the operation has shown a continuously healthy appearance, I believe that there is no doubt of a favorable progress towards a cure.

DIAGNOSIS AND PROGNOSIS.

We can make an accurate diagnosis of the presence of sequestra in those cases only in which we can feel with the probe the movement of a piece of bone, deprived of its periosteum; but there are other appearances which allow us to discover a sequestrum, although with somewhat less certainty: 1. The long duration of a purulent, offensive otorrhœa, which cannot be relieved by the usual treatment. 2. Luxuriant granulations from the tympanum, which cannot be cured, since they again grow rapidly after their removal. 3. When small sequestra have already been eliminated through the external meatus, without diminishing the secretion. 4. When fistulous openings are present behind the external ear, or were present with an abundant and offensive secretion. 5. When under these circumstances. swellings in the neighborhood of the external ear, diffuse infiltration, formation of abscess, or swelling of the lymphatic glands, are present.

When these various symptoms continue, we can diagnose the presence of a sequestrum with the greatest probability, even without being able to gain more accurate demonstration with the sound. In many cases, the symptoms mentioned under 1, 2 and 3 would be sufficient to establish our diagnosis. If the operation reveals no sequestrum, the patient will have been helped, in that the cause of the otorrhœa, namely, the formation of granulations in the antrum, or the caries present, will have been cured, or at least benefited. Even here indeed the result may be

unfavorable, as I had opportunity of experiencing in one case.

In a weakly child, with caries and formation of granulations in the mastoid process, I had removed the granulations and a few carious patches. The strength of the child declined more and more after the operation, diarrhœa set in, and four weeks later there was a violent hemorrhage in the depth of the mastoid process from the posterior upper wall of the cavity, which could only be temporarily staunched, and which resulted fatally.

In making our *prognosis* we have specially to consider the constitution of the patient. Unfortunately we have mostly to do with weakly children of a scrofulous constitution, so that the prospect for a cure is decidedly unfavorable. The more healthy the bodily state of the child operated upon, the better the prognosis for the operation; while under unfavorable circumstances, the progress of the disease of the bone cannot be arrested.

If the case is not operated upon, the sequestrum may be eliminated, as has especially been noticed by Bezold, in this way, that it is pushed out by the formation of granulations towards the external auditory meatus, and can then readily be extracted. No matter how frequent an opportunity we have of observing this procedure, it can indeed only take place in the case of small sequestra, for larger ones, like that found in the three cases described, could not escape from the antrum to the tympanum, and from there outward, since this path as well as that through the tympanum, as also through the external meatus, is too narrow. Even smaller sequestra can only be pushed out along this round-about way, under extremely favorable circumstances. If the sequestrum remains in the antrum, a fistulous opening may be formed towards the external surface, or the secretion may flow off through the external meatus, and the patient stands in danger of losing his life: 1. By a degeneration of the bodily condition with subsequent scrofula or tuberculosis. 2. By extension of the morbid process to the neighboring organs, to the interior of the cranium, and to the great blood vessels. 3. By re-

sorption of inflammatory products, by pyæmia and septicæmia.

As I have previously mentioned, children affected with the diseases described are already scrofulous, and have suffered before, or just after, the appearance of the disease, with inflammation of the eyes, swelling of the glands, etc. The scrofulous symptoms develop themselves further by the continuation of the purulent process, or they appear anew; while, on the other hand, we have opportunities of seeing the symptoms disappear after the sequestrum has been removed. I saw one case of swelling of the glands in the retro-maxillary region with formation of abscess, which disappeared rapidly and was cured, after I had removed a superficial sequestrum of the mastoid process, although every other treatment had proved of no avail. The complications which lead directly to death, only appear, as a rule, when the disease has lasted a long time. Unfortunately, we are unable, with our means of examination, to gain exact knowledge of the extent of the morbid processes present, as well as whether complications dangerous to life are present or not, so that we are never sure in giving a favorable prognosis.

THERAPEUTICS.

Schede has gained for himself the merit of having first used the Volkmann method of operating with the sharp spoon, in diseases of the mastoid processes in children, and in many cases with good results.* Schwartze also treated a large number of cases with Schede's method, and with equally favorable results. In spite of the favorable results which were gained in Halle, since, indeed, the operation was performed before the threatening symptoms had appeared, Bezold has lately expressed the opinion that an operative removal of the sequestrum, before it has advanced towards the aud. meat., is only indicated "when threatening symptoms intimate that the upper or inner wall of the antrum, and the membranes of the brain are beginning to be affected, perhaps also, with a facial paralysis of long duration, if the

* Arch. f. Ohrenheilkunde, Band VI, pag. 287.

sequestrum is already movable."* We could only coincide with this treatment, if we were still able to arrest the process at the approach of threatening symptoms, but when tuberculosis, meningitis, abscess of the brain, or pyæmia are present, we will scarcely succeed, by the operation, in preventing a fatal result. Delaying the operation seems synonymous with doing nothing at all.

It is, on the contrary, of the greatest importance to prevent the occurrence of these complications, and this can only be done by operative interference. We must keep this fact in view, that if we do not operate, the complications must ensue sooner or later, and lead to death, while by the operation we effect a cure under favorable circumstances; whereas, on the contrary, under unfavorable circumstances, we have at least made the attempt to obviate the fatal result which surely would have followed had we not operated. Starting, therefore, from these points of view, I feel authorized, in spite of the unfavorable result of the two cases just described, to assert as a maxim:

We are to undertake the opening of the mastoid process, when we have diagnosed a sequestrum.

As I have just explained, the operation can be performed, not only when our diagnosis is absolutely sure, but also when it seems very probable; since, if we find no sequestrum where we operate, we shall at least have helped the patient, by removing the granulations and carious patches present, and thus favored a cure.

It is very difficult to decide upon the exact period for operating, and I believe that we can only establish the general rule, not to operate too early, since the looser the sequestrum, and the more the granulations have already developed themselves between the sequestrum and the walls of the antrum, so much the more favorable the prognosis. I believe, therefore, that it seems advisable not to operate until the purulent offensive discharge has lasted for some months.

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* Arch. f. Ohrenheilkunde, Band XIII, page 53.

METHOD OF OPERATING.

I have already in a previous anatomical paper, on the perforation of the mastoid process,* called attention to the fact, that at the age of childhood the anatomical relations as regards cutting into the transverse sinus, are more favorable than in adults, since the sinus is curved forward less sharply, and moreover the field of operation downward is not circumscribed. While in adults the curvature of the sinus is especially marked in the lower part of the mastoid process, this curvature is not yet present in childhood. In one hundred specimens in adults, I found the shortest distance between the sigmoid fossa and the posterior wall of the external auditory meatus, 41 times, 1 *cm.* and less (once, 5 *mm.*, five times, 6 *mm.*, and six times, 7 *mm.*), while in the newly born the distance in 40 temporal bones, from the posterior wall of the auditory meatus (measured straight upward and outward from the posterior end of the annulus tympanicus) to the posterior cranial fossa, resp. signoid fossa, never measured less than 10 *mm.*, and averaged 12 *mm*; in twelve temporal bones, from 1–5 years of age, never less than 8, and averaged 10 *mm.*

When we look at the anatomical relations, the thin layers of bone which are found between the antrum petrosum on the one hand, and the middle and posterior cranial fossa on the other, when we further recall to mind that we cannot judge how far the destructive process has advanced towards the cranial cavity, the conviction will force itself upon us that only the most careful interference is justifiable, and Schede even in his first publication warns us to be careful in our use of the sharp spoon. Even if practical experience on the living causes "the boldest use of the sharp spoon" to appear harmless to some operators, it seems to me on the ground of the relations just discussed, that there should be little temptation to gather practical experience on the living by such a procedure.

The operation is to be performed in the following manner: an incision is to be made at the insertion of the auricle, and in

* V. Langenbeck's Archiv., Band XXI., Heft 2.

such a way that the middle of the incision lies just below the level of the opening of the external auditory meatus. If a fistula is present, the incision either goes through the fistulous opening, or is to be united with it by a diagonal incision. In making the incision through the soft parts, we must take care not to turn it forward, since the surface of the mastoid process passes over into the posterior wall of the auditory meatus, without any sharply defined boundaries, and by pressing forward, we run the risk of only loosening the posterior wall of the external auditory meatus, and from here reaching the tympanum. This rule should be especially observed where the soft parts are greatly infiltrated. It seems of importance that the incision should not be too small, but be 2–3 *cm.* long. The edges of the wound must be held apart with sharp hooks, so that after the bleeding has ceased, the field of operation can be thoroughly examined.

In all the cases in which I operated, either a fistula was already present, or after the soft parts were cut through, there was an opening in the bone which could be enlarged with the sharp spoon. In one case only did I have to employ the chisel, in order to enlarge a small opening. The granulations lying in front are to be removed with the sharp spoon. If the antrum is opened and laid bare in this way, it can be examined most carefully with the probe, or with the tip of the finger introduced. If loosened sequestra are present, they can be seized with pincers or forceps, and extracted, or as proves most suitable, may be pried out with the spoon. The sharp spoon also offers the best services in removing the bone that has become softened by caries. The precautionary measure suggested by Schede, to use the sharp spoon only when the bone is found to be softened to a certain degree, is not be neglected.

In my operations I have followed the maxim of confining myself in the removal of the morbid parts to what was most needed, *i. e.*, chiefly the removal of the granulations and the extraction of such sequestra as were fully loosened, and could easily be reached. It seems then necessary in the after treatment to keep the wound open by a thick drain-

age tube, so that in the subsequent days we may have a full view into the depths of the wound, from which now the sequestra gradually loosening themselves, may be detached with the probe and removed. It seems also desirable in the latter stage (as has been emphasized especially by Schwartze and v. Tröltsch) to keep the aperture open as long as possible, by means of a leaden nail, or a short, leaden tube, until we are sure that the mastoid process is in a sound condition. The important point in the after-treatment is the regular removal of the accumulated secretion, for which purpose we prefer syringing at first with antiseptic, later with neutral, and lastly with astringent fluids.

CONCLUSION.

Although in the previous pages I have communicated my experience in the formation of sequestra in the mastoid process of the child, and added the conclusions resulting from my own operations, I must especially note, that I do not by any means cherish the opinion that the question discussed can be already finally decided. After a new stimulus was given from Halle to the operative interference in the diseases of the mastoid process, and Schwartze especially had gained much merit for the operative treatment of these diseases, by the number of his operations, I thought myself justified in communicating the experience which I had an opportunity of collecting in children. Considering the manifold relations which come into account in the diseases and operations in the mastoid process, it seems to me desirable that the special experiences which have been made should be published, since it is only by working together at these questions still in suspense that they can be settled. I shall therefore take it upon myself to communicate in the next volume of these ARCHIVES a few observations, which I have had an opportunity of making in the corresponding diseases of adults.

ON THE SINUS TYMPANI.

By Dr. H. STEINBRÜGGE, in Heidelberg.

Translated by James A. Spalding, M. D., Portland.

IN sawing through the pyramid of a petrous bone belonging to the left side, in which the section was made at right angles to the long axis, and close behind the fenestra ovalis, I found on the lateral segment a noticeable excavation of the wall of the labyrinth, which extended beneath the canal for the facial nerve, almost to the ampullar end of the frontal, as well as the posterior end of the horizontal semicircular canal, and whose deepest portion reached below the floor of the tympanum. As this excavation was unknown to me, I at once examined thirty-seven petrous bones, two of which were from children, nineteen of them being sawed through in the direction just mentioned, and found that the sinus was present thirty-five times in varying size, and in two petrous bones only reduced to a shallow and irregular groove. The tympanic cavities and mastoid cells of both of these bones exhibited traces of previous inflammatory processes. Hence the presence of the sinus may be regarded as normal.

Its situation is somewhat hidden and easily escapes the eye, so long as the hammer and anvil are still in the tympanum. When the wall of the labyrinth is laid open to view by sawing away the outer wall of the tympanum, we gain a distinct view of the entrance into the sinus; but only a comprehension of its form and depth after we have sawed through the pyramid between the sum-

mit of the eminentia pyramidalis, and the posterior edge of the fenestra ovalis. Macerated bones are the most perfect specimens, since the sinus also is invested with a continuation of the mucous membrane of the tympanum, and hence appears smaller and narrower in alcoholic preparations. If the mucous membrane is thickened by disease, the entrance may as a consequence become almost closed.

The sinus lies backward from the round and oval windows, and nearly in the centre between them, always somewhat higher than the former. In regard to direction, its entrance corresponds either to the plane of the wall of the labyrinth, or it is directed obliquely forward and outward, so that it appears more nearly opposite the round window, and has a narrow and fissure-like appearance. In these cases it will be most easily overlooked.

While its anterior and lower edge is formed by the posterior side of the triangle which surrounds the entrance to the cochlea, the eminentia pyramidalis represents the posterior boundary. The form of the entrance is sometimes oval and sometimes horse-shoe shaped. In the former case it appears like a second oval window with its axis perpendicular. The ridge of bone so frequently present, which passes over from the summit of the eminentia pyramidalis to the posterior and lower edge of the oval window, or somewhat deeper to the promontory, forms with the tendon of the stapedius muscle the upper border, or bridges over the sinus, and divides the entrance into a smaller upper, and a larger lower portion.

If we saw through the pyramid in the way just mentioned, the largest portion of the sinus falls into the lateral segment, while on the medial segment only a small groove remains between the round and oval windows. The contour of the larger cavity in the lateral segment resembles somewhat that of a helix, or the half of a heart on a playing-card, divided perpendicularly, the point of which would correspond to the lowest part of the excavation. The eminentia pyramidalis arises in a semicircular shape from the bottom of the sinus, and so appears far larger than one would suppose on looking at it from without.

We learn from this that the tympanum beneath the canal for the facial nerve extends further into the wall of the labyrinth than is usually assumed, and in order to fix these dimensions more accurately, I have measured the height and depth of the excavation (the diameter at right angles to the long axis of the pyramid) in the bones that have been sawed through. The antero-posterior diameter (parallel to the long axis of the petrous bone) is not accurately to be measured in preparations that have been sawed through vertically; it measured 3 *mm.* in a petrous bone that had been sawed through horizontally, and which offered a well-developed sinus.

In eighteen cases the greatest diametrical height measured, three times, 6 *mm.;* the least, 3 *mm.* The average was 4.3 *mm.* The greatest depth measured 5 *mm.;* the least 2 *mm.* The average measurement was 3 *mm.* Furthermore, measurements were made of the distance of the deepest spot of the inner wall of the sinus from the ampullar end of the frontal, and the posterior end of the horizontal semicircular canal, and finally the distance of the same spot in an oblique direction upward and outward to the middle edge of the divided Fallopian canal. The distance to the frontal semicircular canal gave an average measurement of 0.9 *mm.*, to the horizontal semicircular canal 1.4 *mm.*, and to the facial canal 2.5 *mm.* The lowermost part of the sinus sometimes extends below the line of the neighboring floor of the tympanum, which, as is well known, reaches less deeply in the posterior segment than in the middle of the tympanum. The sinus in one petrous bone was united by a passage with a deeper-seated cavity, which bordered closely upon the fossa jugularis.

I did not find any mention of the excavation just described in the later works of anatomy and otology, so far as the literature concerned stood at my command. J. F. Meckel,* however, says in describing the wall of the labyrinth: "The space between the triangular eminence, the promontory and the oval window, forms a distinct excavation, the sinus tympani." Hence it seemed suitable to me

* Handbuch der Menschl. Anatomie. Berlin und Halle, 1820.

to retain this name. Wildberg* speaks of a distinct excavation behind the promontory, over which one or two ridges of bone cross from the eminentia pyramidalis. Schelhammer† especially, amongst the older anatomists, occupies himself with the sinus, and besides communicates many physical researches on the conduction of sound by solid and fluid media, as well as on the reflection of waves of sound. He calls the tympanum concha. In his opinion the waves of sound only reach the labyrinth through the round window; but since the membrana secundaria does not lie directly opposite the membrana tympani, the sinus appears to him necessary to collect the waves of sound that have become dispersed in the tympanum, for the purpose of strengthening even slight tones, and reflecting them into the cochlea. After describing the inner end of the external auditory meatus as a spoon-shaped widening which equals the tympanum in size, he says: "Opposita vero ipsi est statim conchæ pars postica, in qua *nova cavitas* ita efformatur, ut *proxime adjacens* cochleæ foramini exinde immediate sonum immittere in eam possit." And later he says: "Certe qui hæc spernunt, nunquam poterunt causam reddere, cur non e directo vel e diametro, a natura architechrice antra ista (*i. e.*, cochlea and its entrance) sint meatui opposita, ut sine mora sonus illabatur, quod fuisset factu facillimum; quæ omnia declarare nobis minime est arduum, etc." ‡

Although the literature on this theme is not exhausted by these quotations, they will however suffice to prove that the sinus was already known to a few of the older anatomists, but later fell into oblivion. Its presence offers just now only an anatomical interest. Further observations must decide whether it also deserves to be withdrawn from oblivion in a physiological or pathological point of view. But this much can be asserted, that in exudative processes in the tympanum it may be an obstacle to a cure,

* Versuch einer Anatom.-physiol. Pathologie. Abhandlung über die Gehörwerkzenge des Menschen. Jena, 1795.

† De Auditu 1684, Pag. III., Cap. 5, § 1 and Cap. 9.

‡ The author also quotes Morgagni, Vieussens, Cassebohm, and Comparetti. These quotations, being of little value, have been suppressed in the English version of this paper.—K.

just like every other sinuous wound. On the one hand, exudations might be retained in its depths, and on the other hand it might be very difficult, even when the membrana tympani is fully destroyed, to cleanse the cavity described, and to make it accessible to the application of remedies. Since further the inner wall of the sinus reaches to within 0.9 *mm.* of the frontal semi-circular canal, we might imagine the possibility of a propagation of inflammation in carious processes from the tympanum to the labyrinth. But leaving out of consideration the fat that the bony partition wall consists of very thick, compact substance, I could recognize no changes in the preparations that I examined which could suggest any such processes.

EXPERIMENTS WITH EDISON'S PHONOGRAPH.

By Dr. OSCAR WOLF, of Frankfort-on-the-Main.

Translated by Dr. Swan M. Burnett, Washington, D. C.

(*With six wood-cuts.*)

FOR a year now the numerous, rapidly appearing publications of T. A. Edison, and his acoustico-physical instruments: electro-motograph-telephone, the phonograph, the microphone, megaphone, and tasimeter, have figured conspicuously not only in purely scientific circles, but also throughout the whole intellectual world. It seems time, therefore, that a critical sifting be made of that which is essential in these productions from that which is unessential to the furtherance of science.

This sifting, however, cannot be properly carried out just at present, because a number of further investigations are needed to settle the question whether the scientific value and technical application of a part of these discoveries bear a correct relation to the unlimited praise accorded them by the current literature.

I shall limit myself, in this paper, to a consideration of a work of Edison's which is of undoubted value to our branch of science, because it furthers the study of the vibration of membranes as well as the physico-acoustical definition of the sounds of speech, and I shall add a small number of experiments in demonstration of this fact.

As is well-known, the construction of the phonograph rests on the law that tense, somewhat concave membranes are especially adapted for accommodating themselves to

all varieties of sound waves affecting them.* The construction of Edison's instrument is as follows:

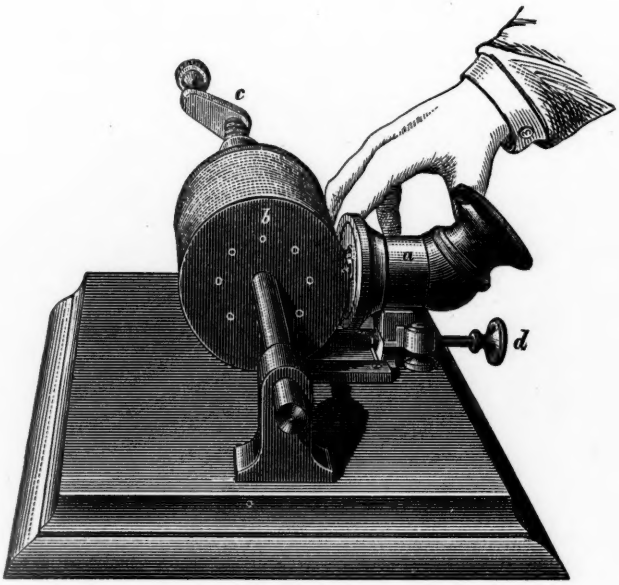

FIG. 1.

At the lower end of a sound receiver *a* (Fig. 1) is attached a small metallic point *s*. This point is applied, with slight pressure, against the metallic cylinder *b* in front of it. This metallic cylinder, revolving on an axle which rests on two supports, is turned by a crank *c*. In one end of the axle is cut a male screw, and in the corresponding part of the support there is a female screw, so that in turning the handle the cylinder not only revolves but at the same time moves in a lateral direction. It is evident then, that a fixed point which lies against this cylinder revolving and moving laterally at the same time, will describe a spiral on the surface of the cylinder. This point would of course imprint a spiral line on a sheet of tin foil wrapped around the cylinder. If the membrane be not vibrating but be in a state of rest, the point attached to it will inscribe a simple smooth line on the tin-foil passing under it. If, however, the membrane is set in vibration by speaking or singing or

* Compare "The mechanism of the ossicles and membrana tympani," Helmholtz—Translation, N. Y., Wm. Wood & Co., 1873, and the author's work "Sprache und Ohr," 1871, p. 187, *et seq.*

playing a musical instrument into the sound-receiver, while the cylinder is moving, the point will impress the corresponding form of the vibration on the tin foil. It impresses, as we may say, the "sound figures" (Klangfiguren.) *

When it is desired to have the apparatus repeat the spoken sounds the metallic point is slightly withdrawn from the cylinder by means of the screw *d*, and then brought back to the position it occupied at the beginning of the experiment. The point is then again brought in contact with the tinfoil and pressed by means of the screw lightly into the first "sound figure," and the cylinder turned as before. While by means of the first turning the vibrations of the membrane cause the point to impress the corresponding "sound-figures" in the tinfoil, on the second turning, these impressions over which the point glides call forth a corresponding vibration of the membrane.

The effect is wonderful; the same words and sentences, with their identical pitch, timbre and rhythm, come back to us from the sound-receiver. And as long as the figures remain distinct, the experiment may be repeated with the same result. We have made a stereotype, as it were, which holds the words, and we have only to turn the cylinder, and the phonograph will speak.

The instrument which I have employed in these experiments is evidently *not yet perfected*, and is capable of improvement. Compared with the action of a sound-conducting apparatus, the proportions of the curved sound-receiver are similar to those of our auditory meatus and the drum membrane, magnified about ten times in all diameters.† The point is set in the membrane to correspond about to the insertion of the hammer-handle. The connection of the membrane to the sound-receiver differs from our sound-conducting apparatus in the following points: The membrane of the phonograph stands at right angles to the wall of the sound-receiver, while the *M. T.*, as is well

* I am of the opinion that these impressions, which can be made out in these various forms by a good magnifying glass and which I will presently describe, can very properly be called "sound-figures."

† The diameter of the circular membrane of the apparatus amounts to 8-9 *cm.*

known, forms an angle of 140° with the upper wall of the meatus (v. Tröltsch). The membrane of the phonograph consists of paper coated with shellac varnish, in order to avoid the effect of the dampness of the breath from speaking into the mouth of the receiver, and it is only slightly curved inward when the point is pressed on the cylinder. If it were possible to prepare a fine *animal membrane* retaining the same curvature and tension as that of the membrana tympani, the vibrating power of the apparatus would be very much increased.

A further desideratum is the substitution of some other metal for the tinfoil, which would preserve for a longer time the figures traced on its surface. Recently it appears that Edison employs a metal alloy, which hardens with great rapidity. This would be much better adapted for acoustic experiments than the tinfoil used by me.

In the experiments which I have made I have had the pleasure of seeing my former investigations on the acoustic peculiarities of the sounds of speech corroborated and extended.*

That the difference in the *timbre* (Klangfarbe) is manfested in the alteration in the *form* of the vibrations is clearly shown by the phonograph. When, for example, the vowel *A* is spoken in a deep bass tone the sound figure is as follows:

FIG. 2.

When, on the other hand, the vowel *A* is spoken in a treble tone (Kinderstimme) the indentations are smaller and shallower as in figure 3:

FIG. 3.

According as the tone of the vowel is sustained for a longer or shorter time will there be a greater or less number of

* See "Recent investigations on the test and derangements of hearing." Archiv. of Oph. and Otol., Vol. IV, No. 1, p. 87.

these sound figures one after the other. The vowel *O* gave a figure about the size of that of *A* as shown in figure 4:

FIG. 4.

The vowels *E* and *I*, on the other hand, impressed much smaller forms on the tin-foil, and the *S* sound, the highest tone of speech, produced the smallest and most numerous impressions (figure 5).

FIG. 5.

The consonants *B*, *K*, *T*, *F* when spoken alone, gave, on account apparently of their weak tone-intensity, no definite sound figures, while in connection with vowels they were given back from the instrument quite distinctly; the words Papa, Bote, Kuckuck, were very distinct. In those cases the sound figures of the vowels are found altered in the same manner as by the tone borrowing sounds *L*, *M*, *N*, and *W*, which, as I have previously shown, modify the commencement and termination of the vowels and in this manner are made perceptible.

In the sound of *R*, on the contrary, the membrane is thrown in very strong vibration, so that the point makes large and tolerably deep, almost round impressions (fig. 6).

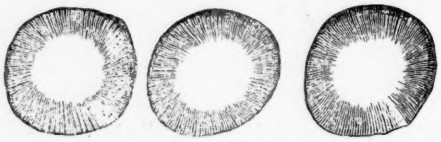

FIG. 6.

Words such as "Hurrah," "Wacht-parade," come out with particular fulness and distinctness. These observations confirm my former opinion that the excursions of the membrana tympani are relatively much greater under the vibrations of the sound of *R*; hence, those patients who have lost a portion of their *M. T.*, hear, in the experiments the *R*-sound with greater difficulty, whilst the *S*-sound is understood in all cases with extraordinary distinctness.

Whether the further observation which was made during these experiments with the phonograph, that after long continued speaking into the receiver, (so soon as the membrane in consequence of becoming damp began to relax) the *S*-sound was the first to vanish, is of any or no value as regards the physiology and pathology of the conducting apparatus, future experiments must decide. This fact corresponds however, with the clinical observation first brought to notice by Moos, that in sclerosis of the drum and its contents, with secondary labyrinth affection, the higher tones and particularly the hissing sounds suffer first of all and are most difficult to understand.

Since our auditory nervous apparatus is extraordinarily sensitive to the highest tones of the scale, so that they can occasion considerable pain to the healthy ear, it is highly probable that the corresponding most sensitive terminal filaments of the nerve are affected, most probably by sympathy, and are therefore the first to be suspended in their function.

Though the phonograph repeats all shades of speech in respect to its timbre, rythm and pitch with tolerable truthfulness, so that from the character of the tone given out from the instrument, one can easily tell who it was that spoke into the sound-receiver, and though the tones of various instruments such as the violin, the clarionette or trumpet can be distinguished from each other, yet the timbre of the tones and sounds reproduced by the membrane is relatively *void of* metallic quality, as it is easy to understand in an instrument composed of a proper membrane and a brass sound-receiver. Finally, it is a very interesting fact that the instrument can be artificially thrown out of tune by a rapid revolving of the cylinder. Let anyone sing any song into the sound receiver, and revolve the cylinder with about the same rapidity at the repetition as when singing into the instrument, the song will then be repeated with perfect purity. If, however, on a second repetition, the revolutions are made more rapid, the song can be transposed, in a certain measure, at will, and pitched one or more tones higher. It is evident that the relations

of the once recorded tones to each other remain the same; on the other hand, the whole number of tones taken together will make a greater number of vibrations in the same length of time and therefore be correspondingly elevated in pitch. In order, therefore, to make exact experiments with the phonograph, it is necessary to have the crank turned by means of machinery, such as a clock-work, which shall revolve the cylinder with the same rapidity during the repetition as when the instrument is spoken into; however, this ingeniously contrived instrument, even in its present form, offers sufficient that is interesting and instructive to the student of Acoustics, to be highly valued for its scientific importance, and to lead to further experiments.

CLINICAL CONTRIBUTIONS TO OTOLOGY,

From the practice of Dr. C. R. Agnew.

Reported by Dr. DAVID WEBSTER, New York.

Case I.—*Pain in the ears with spasm of the Tensor Tympani, caused by the use of strychnia internally.*

Rev. W. C. J., æt. 30, was referred to us by his physician, Dr. Daniel Lewis, on account of a large central scotoma of his left eye which had, for nine months, produced serious "confusion of vision." Ophthalmoscopic examination showed changes in and about the region of the macula. He was placed upon Bichloride of Mercury with Iodide of Potassium for about a month, had several hypodermic injections of a solution of nitrate of strychnia, and was sent home with vision increased from $\frac{8}{200}$ to $\frac{20}{100}$, and with instructions to take one pill containing one-sixtieth of a grain of strychnia, thrice daily.

About three weeks later I received a letter from him in which he said:—"The pills I take regularly, omitting them only when it is necessary, or I forget them. If I am not mistaken they cause a pain in my head, especially in my ears. It comes on after taking them and does not appear when I omit them. The sensation is of *strange* rather than *acute* pain."

As I had given strychnia, both hypodermically and by the stomach, in many cases before, and no patient had ever complained to me of similar effects of the drug, I thought the matter worth investigating further, so I wrote to Mr. J. asking him to describe to me more specifically the effects of the strychnia upon his ears, and suggesting some things which I desired him to note. The following is his reply:—"I do not have any more of the pains n my ears and therefore cannot make the observations you sug-

gest. They stopped two weeks ago. As nearly as I can remember them I will describe them :

"I am in the habit of taking the pills just before or during my meals. When I was having the pains they came about the close of the meal, with a sudden thump, and would beat, for a few minutes, against the membrane of the ear. How long I cannot tell, as I was not in the habit of paying much attention to them and they went away without any absolute consciousness on my part of when, I would simply forget them. The first few beats were all that gave me any very great annoyance."

Pain in the head is not a very unusual effect of strychnia, but this is the first case I have seen or heard of where pain and beating in the ears was observed as an effect of the drug. The beating sensation was, I am inclined to think, due to spasmodic twitchings of the tensor-tympani muscles, and I can conceive it to be possible that the accompanying pain was caused in the same way.

It is true that we have all met with cases of throbbing pains in the ears, occurring as a symptom of acute inflammation of the middle ear, and taking its throbbing character from the pulsations of the heart, propagated through the internal carotid and other arteries in the neighborhood of the drum of the ear. But in the great majority of such cases only one ear is involved. Moreover, pain and throbbing are by no means the only symptoms in such cases. But the history of the above case proves, sufficiently, that the sensations were due to the strychnia, and the only plausible explanation I can think of is the one I have given.

CASE II.—*Mastoid periostitis occurring during the course of "continued fever"—followed by acute suppurative inflammation of the middle ear—incision—recovery.*

Charles D., æt. 69, farmer, was referred to Dr. Agnew by his family physician, Dr. Fred. Corse, of Kingston, Pa., with a letter of which the following is an abstract:—"The bearer, Col. D., was attacked the first of last February with epidemic influenza, at first affecting the nasal and bronchial mucous membranes, subsequently producing severe constitutional disturbance, continued fever and typhoid lesion of the bowels. During the fever the right mastoid process became swollen, red, painful, and extremely sensitive to the touch. As the fever subsided the signs of ulceration of the mastoid cells subsided, *pari passu*, leaving a whitish, inodorous discharge from the right external auditory meatus. Yesterday, May 29th, the region of the mastoid again became

tender and painful without change in the character of the discharge."

The patient arrived at New York a little more than two weeks after the above letter was written. He stated that the pain in and about the ear had been very severe for nearly three weeks, and had increased in severity so that he had not slept at all for the last four nights. He also had a constant roaring in the ear. The tissues over the temporal bone were so swollen as to push the auricle off from the side of the head about three-quarters of an inch. The swelling extended considerably in front of the ear, at least two inches above, and backwards nearly to the occiput, and the whole area was the seat of great tenderness.

The walls of the external auditory canal were swollen and boggy, and prevented a complete view of the membrana tympani, but after syringing out the pus with warm water, by using a very small speculum a bubble of pus could be seen protruding from the depths and on inflating by Valsalva's method this bubble was lifted, but there was no "perforation whistle."

The ear seemed to be totally deaf to external sounds, but heard the turning fork when applied to the forehead or vertex.

The same afternoon Dr. Agnew made an incision down to the mastoid, about one inch and three-quarters in length, and cutting down through the periosteum very thoroughly. The depth of the wound was about one inch at its deepest portion, and the tissues cut through were tough and brawny, and the bone was roughened in spots. Little or no pus made its appearance, and the amount of bleeding was moderate. Lint was stuffed down to the bottom of the wound throughout its whole extent, and hot poultices of flaxseed or slippery elm were ordered to be applied about every two hours. The following day the patient reported that he had rested well, and there was marked amelioration of all the symptoms. In a day or two a slight discharge from the wound set in, and this was encouraged by continued poulticing, the tent in the wound being changed every two or three days. The ear was gently syringed with warm water from time to time, and occasionally inflated by Politzer's method. There was a gradual subsidence of all the symptoms, and in a little over a month Col. D. was allowed to return to his home in Pennsylvania. The discharge from the ear soon ceased, and the organ still remained well when we last saw him more than four years later. The ear did not recover useful hearing, however.

CASE III.—*Inflammation of the mastoid without demonstrable inflammation of the middle ear—incision—recovery with fistulous communication between the mastoid cells and the external auditory canal.*

March 17th, 1875.—Mrs. S., æt. 70, sent for Dr. W. Cheatham, then House Surgeon of the Manhattan Eye and Ear Hospital, now of Louisville, Ky., who noted the following history:

"Five weeks ago, while sneezing, she 'felt' a crackling noise in her right ear. It sounded as if something had burst in the ear. She has suffered intense pain in and behind the ear ever since, and has, in consequence, usually passed sleepless nights. There has been no discharge from the ear at any time. No physician has been consulted. She tried once to relieve the pain by dropping camphorated oil into the ear, but this made the ear worse. She has dropped laudanum into the ear three or four times a day for three weeks, and this has given her some relief.

"She is now suffering very much from pain over the whole of the right side of her head, and extending down her back and neck. There is great swelling, tenderness on pressure, and redness over the mastoid. The swelling of the walls of the external auditory canal prevents examination of the membrana typani. There is facial paralysis of the right side. The patient experiences some difficulty in swallowing, but this, she says, existed before the ear disease.

"She states that her sight has failed rapidly during the last three weeks, and that she sees all distant objects double. She is subject to asthma, but has not suffered from it since the commencement of the ear affection. Hearing was reduced to ability to hear the watch when pressed against the auricle."

I saw the patient on the evening of the same day, with Dr. Cheatham, and made an incision down to the mastoid, about one inch in length, half an inch behind and parallel to the attachment of the auricle. So great was the swelling that the scalpel penetrated to a depth of three-quarters of an inch by measure. No pus escaped, but there was free bleeding. No examination for diseased bone was made on account of the severe pain caused by the incision, the operation being done without any anæsthetic. The wound was well stuffed with lint and hot poultices applied, to be exchanged every three hours. An opiate was given to relieve the pain. *18th.*—The pain continued up to six o'clock this morning when it abated, and at eight o'clock she was found sleeping.

There is slight discharge from the external auditory canal—the first that has been seen. There is less tenderness over the mastoid. She is now able to lie on her right side, which she has not done for the last three weeks on account of the increase of pain so produced. *P. M.*—Visited the patient with Dr. Roosa. She says she feels like a new person. She has slept most of the day without an opiate. The discharge from the auditory canal is much more abundant, and the tenderness over the mastoid is less. Dr. Roosa advised a continuance of the warm poultices.

19*th.*—The patient rested well without an anodyne. Pulse 82; temperature 96½°; appetite and vision improved. Removed tent and inserted a clean one. Poultices to be continued and the ear to be syringed several times a day with warm water.

20*th.*—Tenderness and swelling over mastoid diminishing; pulse 82; temperature 98½°. While exploring the wound with a probe a sinus was found large enough to admit a No. 1 Bowman's probe, a quarter of an inch in length and extending forwards, upwards and inwards from a point nearly opposite the upper portion of the attachment of the auricle. Changed the tent and ordered the poultices to be continued. Ordered fifteen drops of Tinct. Fer. Chlor. three times a day.

23*d.*—Only slight tenderness over mastoid. Found the tent removed and the incision healing.

24*th.*—Found the patient cheerful and much improved. All tenderness gone. To leave off poultices, and dress the healing cut with a greased rag.

26*th.*—The patient says that her appetite is excellent. The double vision has disappeared and she declares that she sees as well as ever. There is still paralysis of the 7th nerve and a slight discharge from the ear. There has never been any discharge from the wound, which is now rapidly healing. The swelling of the walls of the canal is almost gone.

31*st.*—The facial paralysis is much better; she swallows with less difficulty; the incision is nearly healed; there is still slight discharge from the ear. She declares that she feels better than before for six months.

April 12*th.*—The patient came to the Manhattan Eye and Ear Hospital. There is still slight discharge, but the membrana tympani is intact. The posterior wall of the external auditory canal is swollen, and near the junction of the cartilaginous with the membranous portion a teat-like process is seen. This teat-like

process is a small mass of granulation tissue surrounding an opening through which the bent end of a probe can be easily passed. It seems most probably that this opening is the source of the discharge. The facial paralysis has almost entirely disappeared, and the patient now hears the watch on contact.

21*st.*—A slight discharge still continues. The teat-like process remains unchanged, and pus can be seen oozing from it. Dr. Agnew who saw the patient at this visit, advised an incision through the granular mass on the posterior wall of the canal, but the patient objected to it as she "felt perfectly well."

CASE IV.—*Chronic suppurative inflammation of the mastoid cells, with a sinus communicating with the external auditory canal, and without demonstrable inflammation of the middle ear.*

Albie D., æt. 30, states that she began to have noises in her left ear years ago, and that these noises have been accompanied with soreness about the ear, and with pain. The pain often extends to the top of the head, and down into the neck. She is also troubled with dizziness. She has sometimes had a little discharge from the ear after working at it with a hair pin. Her right tonsil is enlarged and she catches cold easily.

H. D. R $\frac{14}{60}$, L $\frac{8}{60}$. The tuning fork applied to the bones of the skull is heard better in the right ear.

In the left external auditory canal is seen a small granular mass, supero-posteriorly, and within an eighth of an inch of the membrana tympani. A No. 1 Bowman's probe, with the end bent at a right angle, is easily hooked into the mouth of a small sinus which is concealed by the small granular mass alluded to. The membrana tympani is intact.

The patient states that she was obliged to give up doing general housework on account of the pain produced in the top of her head by going upstairs, and now follows the occupation of a cook.

No treatment was advised, except that of cleansing the ear daily by syringing with warm water.

Cases II, III and IV, are remarkable as having been cases of primary inflammation of the mastoid cells. All the text-books on the ear treat mastoid cell inflammation as secondary to, or a complication of, inflammation of the middle ear, and I think that it is nowhere stated that the disease sometimes occurs independently of the latter. In Cases III and IV the membrana tympani was found intact, and there was

no evidence that it had ever been perforated; but there may have been a secondary inflammation of the middle ear in both cases, not sufficiently severe to produce ulceration of the drum-head, while the primary inflammation of the mastoid cells was such that in both cases, caries of the bone was produced, resulting in a persistent fistulous opening into the the external auditory canal. In Case II it will be remarked that the mastoid inflammation existed for some time before there was any discharge from the ear, and the latter, indeed, did not make its appearance until the former had subsided.

Although in the majority of cases there is no doubt that the inflammation extends from the posterior nares, along the Eustachian tube, through the middle ear, into the mastoid cells, yet there is no good reason for believing that the inflammation cannot, in the nature of things, originate in the mastoid cells themselves, and travel, perhaps, in the opposite direction.

In some of the following cases the inflammation seems to have followed the usual course, commencing in the middle ear and extending to the mastoid cells.

CASE V.—*Acute inflammation of the middle ear, with inflammation of the mastoid cells, resulting in a fistulous communication between the mastoid antrum and the external auditory canal.*

April 3d, 1873.—C. W. E., æt. 62, merchant, states that three weeks ago he caught a severe cold in his head. He characterizes the cold as an "epizootic," and says that the discharge from his nostrils was very great. About two weeks later his left ear became affected with a sense of fulness and obstruction "as though stopped up with wax," and soon after, broke and began to discharge. The discharge still continues. He has had no pain to speak of, but "constantly hears noises of water and of the beating of the heart." Hearing distance, right, $\frac{14}{48}$; left, click of nails at one inch. The tuning fork applied to the calvarium, is heard more decidedly in the left, or diseased ear. The pharynx is reddened and the uvula elongated. The left membrana tympani is perforated antero-inferiorly, and has a small granulation projecting through the opening. Upon causing the patient to inflate by Valsalva's method pus is forced from the tympanic cavity, and the

external auditory canal is bathed in pus. A small, slightly projecting red spot, on the upper part of the posterior wall of the auditory canal, very near the membrana tympani, attracted our attention, and upon further examination we found this to be the mouth of a fistulous opening through which the end of a bent probe could be easily passed into the mastoid antrum.

The ears were inflated by Politzer's method, and he was instructed to have the left syringed gently, three times a day with warm water.

The patient returned to us three weeks from the date of his first visit with some swelling and tenderness over the mastoid. He had not had any acute pain, but complained of a constant dull aching, "like the feeling produced by a boil." A free incision down to the mastoid, over an inch in length was made, but no pus was found. A tent was introduced and poultices applied, and he was sent home again to be under the care of his family physician. When he came to see us again in three weeks, the swelling and tenderness of the mastoid had passed away, the wound was healed, and the hearing distance had risen from nails 1,″ to nails at 8.″ The fistulous communication between the mastoid cells and the external auditory canal still persisted.

CASE VI.—*Acute inflammation of the middle ear, terminating fatally from brain complication.*

June 16th, 1875.—James M., æt. 60, manufacturer, states that he caught cold, last Friday, by getting wet in the excavation under the East River at Hallet's Point. The following night he suffered from pain and "pulsation" in his right ear. For the last two nights the pain has been so severe as to prevent sleep. The auditory canal is red and swollen in the vicinity of the membrana tympani, which is reddened, bulging, and distinctly pulsating. The Eustachian tubes are open. The watch is not heard in his right ear. The pharynx is red, the tonsils are swollen.

I punctured the membrana tympani and by inflation by Politzer's and Valsava's methods, considerable thick bloody matter was expelled from the tympanic cavity. Ordered frequent use of the warm douche, and an opiate to relieve the pain.

June 17th.—The puncture is healed and the drum-head is again bulging and pulsating. The pain, which was temporarily relieved, has returned. I repeated the paracentesis, again forced out through the opening the purulent contents of the tympanum by inflation, and ordered a leech to be applied half an inch in on the front wall of the meatus.

June 18th.—There is free discharge of pus, and there is still pulsation of the drum. The patient has neglected the leeching. Ordered to have two leeches applied to-day, one behind the ear, and one in the canal.

This gentleman soon after went away out of the city and placed himself under the care of another medical man, and died on the 18th of August, just two months from the date of his last visit to Dr. Agnew's office.

Although no autopsy was obtained yet the symptoms showed very plainly that his death was due to an extension of the ear affection to the brain.

CASE VII.—*Double acute otitis media, with inflammation of both external auditory canals, and both mastoid processes, supposed to have been caused by the use of the nasal douche.*

J. B. N., æt. 34, lawyer, states that on the first of January he had an attack of typhoid fever which was broken up by treatment after it had lasted just one week. He caught cold on January 10th, during convalescence, and had a severe nasopharyngeal catarrh. He used the nasal douche, with simple warm water, on the 10th, 11th, and 12th. His ears were very painful on the morning of the 13th, and he quit using the douche, believing the pain to be due to water extering his middle ears through his Eustachian tubes.

Inflammation of his left mastoid process set in, and he was confined to his bed for ten weeks. He was delirious for the first five days.

He has, at present, May 14th, inflammation of both external auditory canals, completely hiding from view both membrana tympani. The skin over both mastoids is reddened, and there is a tender point at the antero-inferior portion of each. The Eustachian tubes are probably open as Valsalva gives great pain. The pharynx is reddened and granular, and there is considerable discharge from the nares. Hearing distance, right, $\frac{7}{48}$, left, $\frac{1\frac{1}{2}}{48}$. Tuning fork heard equally well in both.

CASE VIII.—*Chronic suppurative inflammation of middle ear with mastoid complication—benefited by incision down to mastoid.*

Oct. 29th.—Miss Ada S., æt. 16, scholar, has long had discharge from right ear caused by scarletina. For the last four months she has had pain in the head and tenderness over the mastoid. She sometimes gets "so dizzy that she cannot see." She has constant pain or soreness over the right side of her head, through the

temple and extending to the vertex. She hears the tuning fork in the right ear when applied to the head, but cannot bear the click of finger nails. The auditory canal is filled with pus, which being washed away, discovers a polypoid mass hiding the membrana tympani from view. The Eustachian tube is open, inflation producing a perforation whistle.

Nov. 1st.—Made incision one inch long, down to the mastoid. Free bleeding followed. Dressed with vaseline and absorbent cotton.

Nov. 6th.—Has had much less dizziness since the mastoid incision. The discharge from the ear has increased. Probed the wound throughout its length and dressed again.

Nov. 18th.—For more than ten days has had no pain in the head, and the dizziness occurs rarely, and only when she walks in the sun. Applied a blister of cantharidal collodion back of the cut.

Dec. 14th.—The hearing distance has increased from inability to hear the click of nails to $\frac{16}{48}$, and ability to hear words spoken in an ordinary tone of voice all the way across the room. She has kept up counter irritation with the blistering collodion. A granulation is springing up from the whole length of the cut. To allow the cut to heal, and to keep the ear cleansed with a solution of carbolic acid. She complains no longer of dizziness or headache.

This case is remarkable for the improvement in the hearing which took place under treatment, and the rapid improvement in the symptoms which followed the cut through the mastoid periosteum.

CASE IX.—*Acute inflammation of the middle ear with labyrinth complications, caused by the use of the nasal douche.*

D. S. G., æt. 41, musician, has been troubled with nasopharyngeal catarrh for three years, during which time he has used the nasal douche, as ordered by his physician, but not daily. The first trouble he ever noticed with his ears was about a year ago, when he observed that the air whistled through his left ear while blowing his nose. He has never had any discharge from either ear, and only slight tinnitus until the present acute attack. About ten days ago he used the nasal douche for the last time. The application gave him a violent pain in the left ear, and this continued until relieved by the application of six leeches, three behind and three in front of the ear. The singing and roaring noises have been very annoying since the commencement of the trouble. For

the first eight days he heard everything a second time, like an echo from a great distance. A piano in good order sounds horribly out of tune to him.

Status præsens.—Hearing distance, right, $\frac{30}{48}$; left, $\frac{4}{48}$. Tuning fork applied to the skull, heard more in left than right. Pharynx hyperæmic, nares dry, external auditory canals normal. Left membrana tympani reddened along the handle and at the periphery, and sunken.

This patient was thoroughly inflated by Politzer's method, but did not return for further treatment.

CASE X.—*Subacute inflammatiou of the middle ear from the use of the nasal douche.*

H. C. W., æt. 31, lawyer, has been troubled with catarrh for a long time and has used the nasal douche for several years. When he used it the last time, several days ago, he felt the water enter his right ear. The ear has felt very sore and disagreeable since, but he has had no real pain. There is no tinnitus. He has long been in the habit of trying to relieve an itching sensation in his auditory canals by scratching them with a hair pin.

Hearing distance, right, $\frac{15}{60}$; left, $\frac{60}{60}$. The tuning fork in contact with the head is heard more in the right ear. The pharynx is granular, and the external auditory canals are somewhat obstructed by exfoliated epidermis. The right membrana tympani is reddened, and shows no light spot. The Eustachian tubes are open.

This case was treated successfully by leeching and inflation by Politzer's method. It is remarkable only for the mildness of the inflammation caused by the entrance of water into the ear through the Eustachian tube.

CASE XI.—*Acute inflammation of the middle ear apparantly caused by rupture of the drum-head while blowing the nose.*

S. P. W., clerk, æt. 24, states that on Friday morning, while blowing his nose, something seemed to give way in his ear, and the air whistled through. The ear became painful at once, and the pain continued until bed time. He experienced the same sensation on blowing his nose on Saturday morning, and he has had severe pain in the depths of his ear ever since. This morning (Monday), it commenced running, but is still painful. The pain is less severe when he is quiet. He has considerable tinnitus, and hears the watch only in contact. The turning fork is heard more in the painful ear.

The left external auditory canal contains pus, the membrana tympani is reddened, swollen and perforated, the air whistling through, and the pus bubbling out, on inflation by Valsalva's method.

He was treated successfully by leeching, the warm douche, and inflation.

Although the patient believed that violently blowing his nose was the first cause of the trouble, I think it more probable that there already existed a painless otitis media, and that the drum-membrane was already ulcerated and ready to burst when the forcible entrance of air through the Eustachian tube completed the perforation, and thus gave an impetus to the pre-existing inflammation, producing the severe pain.

CASE XII.—*Subacute inflammation of the middle ear with fluid in the tympanic cavity—puncture of the drum-head—recovery.*

May 19th.—B. N. F., æt. 51, farmer has had for the last three months, a crackling or ringing noise in his left ear which interferes seriously with his comfort. It originated in a cold which he caught in February. Occasionally he has slight pain which he refers to the tragus. He states that he had a similar attack twenty years ago from which he recovered without treatment. His voice is a little hoarse, and his throat the seat of a follicular pharyngitis. There is a copious secretion from his nares. Hearing distance, right, $\frac{8}{60}$; left, $\frac{2}{60}$. The tuning fork is heard better in the left ear. Both Eustachian tubes are pervious. The left membrana tympani is of a dirty yellowish color with a light spot of normal shape, but of diminished brilliancy. Upon inflation, air bubbles were seen through the membrana tympani rising slowly and bursting in the upper part of the cavity. The drum-head was punctured and air was forced through, carrying along with it a quantity of Malaga-grape colored fluid, enough to trickle out of the meatus. Half an hour later the noise had ceased and the hearing distance had risen to $\frac{6}{60}$.

May 23d.—There has been no tinnitus since; there is no evidence of fluid in the tympanic cavity; the hearing remains at $\frac{6}{60}$.

I saw the patient about two years later and he stated that there had been no recurrence of the ear trouble.

CASE XIII.—*Subacute inflammation of the middle ear, with fluid in the tympanic cavity—relieved by puncture of the drum-head.*

Mrs. J. S., æt. 50, had a roaring in the right ear last winter, which passed away after a short time, but returned about a week ago. Never had pain, or discharge from the ear, but there has been some dulness of hearing. Sometimes she can hear as well as ever with the right ear when lying on her back.

Hearing distance, R. watch in contact, L. normal. Tuning fork heard only in R. Chronic pharyngitis. The lower part of the right membrana tympani has a yellowish look; the head of the stapes can be seen indistinctly; the light spot is very large, but not bright.

Air seems not to pass into the ear by Politzer's or Valsalva's method.

As the history of the case and the appearances of the membrana tympani led us to suspect that there was fluid in the tympanic cavity, Dr. Agnew punctured the drum-head. Immediately on puncturing a bubble of air was seen in the cavity, but we could not blow either air or fluid through the perforation by Politzer's or Valsalva's method or by the Eustachian catheter. The use of Siegle's otoscope was then resorted to, and by making powerful suction while the patient endeavored to force air through his Eustachian tubes by Valsalva's method a comparatively large quantity of mucilaginous, Malaga-grape colored fluid was expelled. More of this fluid was afterwards expelled by Politzer's method, amounting to about one drachm in all. Before the patient left the office the hearing of the ear had gone up to $\frac{6}{48}$.

The large quantity of fluid evacuated in this case is conclusive evidence that the mastoid cells as well as the tympanic cavity were filled with it.

CASE XIV.—*Subacute inflammation of the middle ear with fluid in the tympanic cavity—relieved by puncture of the drum-head.*

L. A. W., æt. 27, baker, had his first spell of deafness and earache at the age of fifteen. Again, two years ago, he had a great deal of roaring noise in the left ear. This lasted for six or eight weeks, but passed away after inflation of the ears by Politzer's method. Last winter he had the same roaring and deafness for about two months, but got well without any treatment. The present attack came on about the first of August, got better without treatment, but now, Dec. 3d, is worse than ever. There is a constant noise in the left ear like the sound of a cataract. Up to two or three days ago this noise entirely disappeared on lying

down. Now, with head erect the hearing is $\frac{6}{48}$, with the head thrown back, $\frac{36}{48}$, but the noise still continues. The drum-head looks reddish, but no air seems to enter the middle ear on the use of Valsalva's or Politzer's method.

This being a clear history of fluid in the cavity of the tympanum, Dr. Agnew, by means of a narrow Graefe's knife, incised the drum-head from the end of the handle of the malleus to the infero-posterior margin. Still, the patient could not expel any fluid or air by Valsalva's method, but by a forcible use of Politzer's method, at least five or six drops of Malaga-grape colored fluid were expelled. Immediately after, the hearing rose to $\frac{36}{48}$ with head erect. The patient said that the noise was so diminished that it felt like another ear. He was told to syringe the ear with warm water, but the following evening syringed it by mistake with a solution of Bichcloride of Mercury (gr. vi., ad. $\frac{7}{3}$ i.). This caused smarting at the time, and he had severe, burning pain in the ear for several minutes. The next morning the wound in the drum-head was found closed, but was reopened by forcible inflation. Three days after the operation, the patient heard the watch five feet with each ear. He stated that the ear which had contained the fluid felt, in every respect, as well as the other.

These cases of chronic or subacute inflammation of the middle ear with fluid exudation in the drum are not very common. I have seen several, however, besides those reported above, and they all, so far as I know, terminate favorably, after ridding the tympanic cavity of its fluid contents. In one case which I treated at the Manhattan Eye and Ear Hospital, the inflammation took an acute form after the puncture, and there was a discharge of pus for some weeks, but the inflammation eventually passed away leaving useful hearing.

Cases of acute inflammation of the middle ear, with the drum filled with pus, are met with much more frequently; and in many such cases it is good practice to anticipate a perforation by puncturing the drum-head. I adduce a few cases.

CASE XV.—*Acute inflammation of the middle ear treated by puncture of the drum-head—recovery.*

March 9th, 1875.—S. H., æt. 60, sashmaker, states that his right ear has been deaf since childhood. On the 28th of February he came

home from church deaf in his left. He was soon attacked with pain behind and in front of the ear, and much noise and throbbing in the ear. The same night there was a discharge of bloody matter upon the pillow.

Hearing distance $\frac{2}{60}$ in each ear. The right membrana tympani is sunken and cicatricial, the left is reddened, swollen and bulging.

Punctured the drum-head, and by inflation by Politzer's and Valsalva's methods, expelled a considerable quantity of bloody, whey-like fluid.

The ear recovered in a week or ten days under leeching, warm syringing and inflation.

CASE XVI.—*Acute inflammation of the middle ear with pus in the tympanic cavity—puncture of the drum-head—recovery.*

May 22nd.—P. C., æt. 35, laborer, caught cold in his head and has suffered from severe pain in his left ear for twenty-four hours. The ear hears a watch in contact, and the tuning fork, placed in contact with the head, better than the right ear which is normal. The left mastoid is tender to the touch, and the membrana tympani is red, swollen, and has three bleb-like elevations upon its surface.

A free incision was made through the drum-head, posterior to the malleus handle, and several drops of thick pus were expelled by inflation.

May 23d.—The patient states that he has had no pain in the ear since incision was made. He is still able to expel pus by Valsalva's method.

The ear recovered rapidly from this time.

CASE XVII.—*Acute inflammation of the middle ear with pus in the tympanic cavity—drum-head punctured thrice—recovery.*

March 17th.—Miss B. L., æt. 25, waitress, states that nine days ago, while suffering from a cold and a sore throat, pain came on in the left ear and she has suffered more or less acutely ever since. There is a roaring noise in the ear, whose hearing is reduced to $\frac{1}{48}$, and in which the tuning fork is heard better than in the normal ear. The drum-head is red, swollen, and bulging, and the back wall of the auditory canal is red, swollen, and ulcerated. Eustachian tubes open.

After puncturing the drum-head the patient forced air through his Eustachian tube, expelling pus from the drum, and producing the "perforation whistle."

March 18th.—The incision has healed; punctured again, and expelled more pus from the drum by Politzer's method.

March 19th.—The wound is again healed, and the drum-head bulging. Punctured a third time, and expelled pus as before.

March 20th.—Free discharge of pus from the ear; air is easily forced through the perforation; the boggy spot on the back wall of the canal has disappeared.

March 30th.—The discharge has ceased, and the noise is again troublesome. The patient also complains of headache, dizziness, and pain back of the ear.

Two leeches were applied half an inch in on the front wall of the ear, and the warm douche used frequently.

April 6th.—The headache and pain over the mastoid have disappeared, and there is now only occasional tinnitus. The membrana tympani is only slightly red, and the hearing has increased to $\frac{8}{48}$. The patient suffered no relapse after this.

EXTENSIVE CASEOUS OSTEITIS OF THE MASTOID PROCESS AND PETROUS BONE, CAUSED BY CHRONIC PURULENT INFLAMMATION OF THE MIDDLE EAR.—OPERATION.—PERMANENT FISTULA OF THE MASTOID—RECOVERY.

By A. G. GERSTER, M.D.

Surgeon to the German Hospital and Dispensary, New York.

The following successfully operated case of mastoidal abscess is cited to encourage others to prompt action in similar instances.

Jan. 14th, 1879, F. B., æt. 25, an emaciated German laborer was admitted to the German Hospital. He presented symptoms of a profusely purulent and fetid discharge of the right ear, dating back to infancy. For two years past numerous abscesses had formed about the mastoid process, and after being opened, they never healed. Being subject to constant headaches, sleeplessness and frequent attacks of fever, the discharge meantime becoming intolerably putrid, he finally sought to obtain relief from a physician in Jersey City, who performed Wilde's incision. The severity of the symptoms subsided only for a short time, and the patient at his admission was anxious to undergo any operation that would offer him a chance of recovery. Inspection revealed facial paralysis on the right side, and considerable sclerotic thickening of the soft integuments of the mastoid region; also three fistulous openings surrounded by flaccid, unhealthy granulations, through all of which a probe passed readily into the body of the mastoid process, where diseased bone could be felt. The functional ability of the organ, both as regards conduction by air and bone, was totally destroyed.

Jan. 21st.—By a C-shaped incision of five inches and a-half, the bone was exposed in the whole extent of the postaural region. Ligatures being out of question on account of the rigidity of the integuments, the profuse hemorrhage was controlled by digital

compression. Then the periosteum was detached and the edges of the wound were held apart by sharp hooks. Near the centre of the surface of the mastoid process we found a small opening the size of a pea, leading into a cavity filled by very offensive caseous masses. By the aid of a chisel and mallet, this opening was sufficiently enlarged to admit the index finger. The apex of the process was found to be attached to its base by a mere lamina of bone; this was broken off and severed from the sterno-mastoid muscle. Thus an astonishingly large cavity was exposed; it penetrated into the petrous bone forwards and inwards an inch and a quarter, and was estimated to be somewhat larger than a pigeon's egg. Its walls were perfectly smooth and hard, with the exception of the margin of a good sized communication existing between the middle ear and the mastoid cavity, where carious bone could be felt. All the pathological deposits were now removed by the aid of a scoop, and a stream of a solution of carbolic acid, directed into the meatus, returned readily through the newly established ostium. On inspection it was ascertained that only rudiments of the membrana tympani existed. At the upper and inner side of the roof of the mastoid cavity, a fissure-like opening could be seen which obviously led towards the labyrinth. All the fistulæ in the soft integuments were divided, among them one situated parallel with, and behind the sterno-mastoid muscle, reaching downwards an inch and a half; some caseous glands in this neighborhood and the flabby granulations were vigorously scooped out, then the bleeding was staunched by plugging with Lister's gauze, and the wound was antiseptically dressed.

No reaction followed the operation; the patient's temperature never rose above 101.0° F., the first week, and always remained normal afterwards; his headache and sleeplessness disappeared entirely, so that he could rest well without the aid of narcotics for the first time in a year. The third day after the operation the secretion became putrid owing to a fault in the dressing. A one per cent. solution of acetate of alum was substituted for the carbolic acid, the latter failing to deoderize the wound; the cavities were irrigated every two hours, and two days later the foul odor disappeared and healthy granulations formed. Excepting where it was purposely kept open by a drainage tube, the incised wound healed kindly. *Feb. 28th.*—The *cavum tympani* and the cavity in the mastoid process appeared to be coated with a smooth, shining mucous membrane; the fissure towards the labyrinth was

firmly closed; secretion minimal, and the general condition of the patient had improved remarkably.

It was observed in the course of the treatment that when irrigation was less frequently resorted to, the secretions of the middle ear, however slight, collected in the mastoidal cavity and were condensed to a cheesy substance. Therefore, to insure daily irrigation, it was decided to make the existing fistula permanent. A properly constructed silver *canula*, with a kidney-shaped flange, was inserted into the opening and is being worn without discomfort, merely secured by a fitting piece of *emplastrum cerussæ*.

Regarding the operative procedure, it may be said, that the use of such instruments as the trocar and trepan, the action of which cannot be kept under visual observation, is, to say the least, unsafe. The employment of the chisel and mallet seems to offer the greatest security. Several advantages will accrue if the action of the chisel is tangential to the surface of the cranium: *First*, the bone will be opened layer by layer, and thus laceration of the transverse sinus be best avoided; *secondly*, the cavity of the abscess is converted into a shallow basin that will afford excellent drainage.

ON THE INDICATIONS OF OPENING THE MASTOID PROCESS IN CASES OF OTITIS MEDIA PURULENTA ACUTA WITH IMPLICATION OF THE MASTOID CELLS.

By Dr. EMIL GRUENING, of New York.

THE operation of perforating the healthy bony tissue of the mastoid process with the sole view of liberating purulent matter confined within its air-cells, has not yet been performed so frequently as to render the recorded material available in determining the exact conditions justifying the attack on the bone with drills or chisels.

In perusing the report of Schwartze's* very instructive series of fifty cases of perforation of the mastoid, I find eleven pertinent cases, and among the latter but two (Nos. 25 and 26) of acute otitis media purulenta resulting in the retention of pus within the mastoid cells.

Buck's† paper on "the diseases of the mastoid process, etc.," contains a number of interesting cases, of which, however, I can select but one, (Case XIV) as bearing upon the matter under consideration.

Our subject is the study of those cases in which from certain signs the presence of pus within the mastoid cells has been assumed and actually demonstrated.

That the indications for the perforation of the mastoid process are not precisely formulated, is evident from the fact that the able and experienced advocate of the operation, Schwartze, has been repeatedly deluded in his expectation of finding pus. For our purpose it is of little import that the revulsive action (as Schwartze terms it) of the

**Arch. f. Ohrenheilk.*, Vol. X, 1, 2, 3; Vol. XI, 2; Vol. XII, 2; Vol. XIII, 1, 4.

†*Archives of Ophthalmology and Otology*, Vol. III, No. 1, p. 173.

assailed bone seems to influence favorably the course of the disease; the fact remains that the operation undertaken with a view of finding pus did not accomplish its object. The consideration then that more clinical material must be gathered in order to find absolute indications prompts me to give an account of two cases of acute otitis media purulenta with extension of the inflammation to the mastoid cells, and accumulation of pus therein, necessitating perforation of the bone.

CASE I.—Michael Moses, æt. 32. The patient has always enjoyed good health. His hearing was unimpaired until August, 1874, when, after a sea-bath, he experienced a sensation of fulness and dull pain in his right ear. The pain, moderate at first, increased rapidly, and did not abate until several days later, when a profuse discharge of matter ensued. The patient did not place himself under my treatment until the otorrhœa, attended with headache, tinnitus and vertigo, had lasted four weeks. On examination the external auditory canal of the right ear was found filled with fetid pus, the removal of which exposed to view the slightly reddened but otherwise normal lining of the canal and a small perforation of the drum-head in its infero-posterior quadrant. Eustachian tube permeable. Ticking of the watch heard only by conduction through the bones of the head. The region of the mastoid process reddened, œdematous and painful on pressure. I ordered the application of five leeches to the mastoid process, and instillations of a one per cent. solution of zinc sulpho-carbolate, together with the internal administration of a dose of calomel and jalap.

The immediate consequence of the local depletion was a subsidence of the pain, while the tenderness on pressure over the mastoid seemed even increased. The improvement in the subjective symptoms was of short duration; twenty-four hours later the pain had recurred with increased intensity, and radiated from the mastoid process to the temples and the occiput. The discharge from the ear was scanty. I performed Wilde's incision, carrying it from the apex of the mastoid upward to the extent of one inch and a quarter, and found the bone perfectly healthy. The wound bled freely, and the patient experienced much relief. During the following night the pain recurred with great violence; the patient became delirious, had several rigors, vomited repeatedly and responded sluggishly, though coherently, to loud ques-

tions. Temperature (in rectum) 105.° At daybreak, October 11th, 1874, I proposed the immediate perforation of the mastoid process.

Dr. A. H. Buck, who had been called in consultation, agreed with me as to the necessity of opening the bone, and with the kind assistance of this gentleman and Drs. Blume and Munson, I performed the operation with a drill, placing it on a level with the upper wall of the meatus, in the immediate vicinity of the auricle. It is unnecessary to describe minutely the various steps of the operation, which differed in no wise from that practiced formerly by Schwartze and Buck. The outer shell of the bone measured but 3 *mm.* in thickness, and a few rotations of the drill sufficed to lay open the antrum mastoideum, and give exit to a considerable quantity, about two teaspoonfuls, of creamy, inodorous pus. A probe introduced through the perforation encountered no dead bone, but transmitted the sensation of a perfectly smooth cavity. On irrigating the mastoid cells, it was found that the communication between the latter and the tympanic cavity was obstructed, inasmuch as the water did not escape either through the Eustachian tube or the outer ear.

Immediately after the operation the patient felt considerably relieved. His intellect was unimpaired. Temperature 101°.

At the next irrigation the following morning, the water escaped both through the outer ear and the Eustachian tube. On the fifth day the patient was up and free from all headache and dizziness. The otorrhœa soon ceased, but the hole in the drum-head did not close. Three months after the operation the patient could hear the ticking of the watch at a distance of one foot.

At the site of the operation a fistulous opening remained, which closed two years later, after the extrusion of several fragments of bone.

Case II.—Louis Baer, æt. 42, musician, came under my care on the 13th of April, 1877, suffering with otitis media purulenta. The patient, who has been affected with phthisis pulmonum for several years, states that a few weeks ago he was seized with a violent earache, followed by a purulent discharge from the left ear, and impairment of hearing. A few days ago the pain in the left ear returned, attended with nocturnal exacerbations.

Present condition: On removing the purulent accumulations obstructing the canal, a large perforation of the drum-head is seen in its infero-anterior quadrant. The deeper portions of the ex-

ternal auditory canal, especially the posterior half of the roof, are markedly congested, bulging, and very tender on pressure. The mastoid process is œdematous, swollen and tender. Ticking of the watch audible on left side only when closely applied to ear; on right side at a distance of three inches.

The application of five leeches to the mastoid process was followed by considerable abatement of the headache for a few hours, after which time it returned with increased intensity.

On the 14th of April, after thoroughly cleansing the auditory canal, I made an incision through the skin and the periosteum of the mastoid process. The wound bled freely, and the patient obtained considerable relief for several days. The pain returned on the 17th of April. Inspection of the external auditory canal showed the same conditions as previously. I now made a free incision through that portion of the upper wall of the external auditory canal which adjoins the drum-head; found the bone rough, and, by firm pressure with a probe, succeeded in penetrating through the same into the mastoid cells and liberating a considerable quantity of thick pus. The patient at once experienced great relief; the pain disappeared completely, but again returned in three days with increased severity. I could still pass a curved probe from the external canal into the mastoid cells, but only by forcing a passage through the granulations which now obstructed the opening. The withdrawal of the probe was followed by free hemorrhage, which gave so much relief to the patient that I renewed the procedure several times at the same sitting. The following day a repetition of the probing did not cause any abatement of the pain. Patient screamed and groaned constantly, and complained of occipital headache. *T.* 102°, *P.* 120.

I now determined to perforate the mastoid process. The periostreum and the external shell of bone appeared perfectly healthy. The mastoid cells were perforated with a drill without appreciable difficulty, and about a teaspoonful of pus was evacuated. On introducing the probe I encountered a piece of loose bone, which had very probably been pushed in from the external auditory canal. Having enlarged the opening in the bone with a conical drill, I removed the fragment of carious bone. On irrigating the cavity of the wound, the water found its way out through the external auditory canal, washing away some pus and caseous particles. The immediate result of the operation was very satisfactory. At the end of two months the otorrhœa had ceased and the mastoid wound had cicatrized.

From the meagre statistics at my disposal I cannot draw conclusions of general applicability, and shall therefore content myself to indicate the features common to both cases, and thus try to aid in establishing more precise indications for the opening of the mastoid process. In the two cases of acute purulent otitis media, attended with high fever, the inflammation spread to the mastoid process which presented redness, swelling and great tenderness, and moreover, became the seat of violent pain, radiating towards the temple and occiput. Application of leeches to the mastoid and Wilde's incision caused but little improvement, inasmuch as the febrile condition persisted and the pain recurred speedily. Perforation of the mastoid process was followed by evacuation of pus, great relief and rapid recovery.

REPORT ON THE PROGRESS OF OTOLOGY.

IN THE FIRST HALF OF THE YEAR, 1879.

I. NORMAL AND PATHOLOGICAL ANATOMY AND HISTOLOGY OF THE ORGAN OF HEARING.

By H. STEINBRUEGGE, of Heidelberg.

Translated from the German edition, by Isidor Furst, New York.

1. Kleine Beiträge zur normalen and pathologischen Anatomie des Gehörorgans. [Minor Contributions to the Normal and Pathological Anatomy of the Organ of Hearing.] By Dr. K. Buerkner, of Göttingen. *Arch. f. Ohrenheilkde.*, 1878, Bd. XIII., Heft 2 and 3.

2. Dritter Beitrag zur Anatomie des Schläfenbeins. [Third Contribution to the Anatomy of the Temporal Bone.] By Dr. E. Zuckerkandl. *Monatschrift f. Ohrenheikde.*, Nos. 3 and 4.

a. On Atrophy of the Petrous Bone.

b. On a Typical Formation of Fissure in the Posterior Wall of the External Auditory Meatus.

c. Fourth Contribution to the Anatomy of the Organ of Hearing. By the same Author. *Monatsschrift f. Ohrenheilkde.*, 1878. No. 7.

3. Zur Kenntniss der sogenannten Dehiscenz des Tegmen Tympani. [Contribution to the Knowledge of the so-called Dehiscence of the Tegmen Tympani.] By Dr. Max Flesch, Demonstrator of Anatomy in Würzburg. *Arch. f. Ohrenheilkde.*, Bd. XIV, Heft 1.

4. Case of Abcess of the Cerebellum, bursting into the Ear, with Immediate Death. By G. C. Gribbon. *Lancet*, 1878, Bd. I., No. 20.

5. Ueber das Vorkommen und die Bedeutung phosphorsaurer Kalkconcremente im Stamme des Gehörnerven. [On the Occurrence and the importance of Concretions of Phosphate of Lime in the Trunk of the Auditory Nerve.] Lecture read at the meeting

of Southwestern German Neurologists and Physicians for the Insane, at Wildbad, May 20th, 1878, by Prof. DR. MOOS.

6. Mangel der Halbzirkelgänge im rechten Felsenbein bei einer Taube. [Absence of the semi-circular Canals in the Right Petrous Bone of a Pigeon.] By H. MUNK. *Arch. f. Anatomie u. Physiologie*, Jahrg. 1878, Physiol. Abth., 3d and 4th Heft. Session of the Physiol. Society at Berlin, July 11th, 1878.

BUERKNER (1) contributes researches on the fissure in the ossification of the external auditory meatus, on the dehiscences of the tegmen tympani, as well as on an isolated cartilage in the infantile auditory meatus. Regarding the fissure of ossification, the statements of earlier anatomists who have touched on the subject (Riolan, Du Verney, Casselbohm, Lincke, Huschke are cited); while others, Blummenbach and A. F. Günther do not appear to have recognized it. Hymphry first correctly described the formation of the external auditory meatus and the fissure; Hyrtl distinguishes between the fissure owing to the motions of the head of the ramus of the inferior maxillary bone and those depending on imperfect ossification; and Toynbee in his Catalogue enumerates six temporal bones with this defect. Thorough researches on this subject were subsequently published by v. Tröltsch and Gruber, and lately by Rüdinger and Zuckerkandl. The latter describes the formation of excrescences on the annulis tympanicus, the so-called tubercula tympanica antica and postica, which, converging externally, unite at their apices, whereby a fissure-like opening is formed below, which is said to persist up to the seventh year. Anatomists differ as to the time of closure. Bürkner's researches comprise the large number of 1178 skulls of different races, belonging to the collections of Würzberg, Dresden, and Frankfort (Senkenberg's) Of 332 of these, the age was given; of 91, it could be definitely, of 775 only approximately determined. The appearance of the tubercula tympanica is not confined to any one fœtal month; but, as is shown by an appended table of 118 infantile skulls, cannot be demonstrated before the seventh fœtal month; while the numbers vary in the months of the first year of life, and reach the highest figure at its end. The posterior tubercle appears later, but grows more rapidly (Rüdinger). The completion of the fissure seems to fall in the second year; its shape is very variable, but the oval or crescent shape, with a larger transverse and a smaller longitudinal diameter, predominates. By furcation of the tubercles, several fissures may form, or, when the

excrescences do not meet, fissures with greater longitudinal diameter. The defect is mostly bilateral. Shape and size of the fissures vary greatly and admit of conclusions as to the age of the individual. As regards the closure of the openings, a tabular statement proves that they become more rare from the fifth year, but the author still found 37.5 per cent. in the fifteenth year, including the unilateral defects. He further saw, among 982 skulls of adults, 19.2 per cent. showing partly unilateral, partly bilateral fissures, 12.5 per cent. of which undoubtedly dated from infancy, and could not have been owing to friction or other mechanical causes. The size of the fissures of ossification in adults is smaller than in children, their form more angular, their rim less serrated. Their frequency is in inverse ratio to the age. The middle age yielded 17 to 18 per cent. Then follows a table of 1060 adult and infantile skulls, placing together according to age the cases of unilateral, bilateral, and absent fissures. This table proves that unilateral fissure predominates, and, moreover, that neither side seems to preponderate particularly. Further tables show an overbalance of the fissures in number and size in the female sex. No material difference could be demonstrated in one or the other race as to frequency of occurrence.

In contradistinction to the rounded and solid appearance of fissures of ossification, the author then points out the crumbling and corroded aspect of a carious defect which was found in a left auditory meatus accompanying caries of the cochlea.

Bürkner, then, in a second section, turns to the discussion of the dehiscence of the tegmen tympani. Cassebohm, Toynbee, Hyrtl, v. Retzino, v. Trŏltsch, and others mention its occurrence ; but respecting its formation a difference of opinion prevails, to which we shall recur at another place. Bürkner observed a frequent coincidence of pronounced *impressiones digitatæ* with dehiscences of the tegmen and other thinnings of the skull. Among 44 skulls showing perforations of the roof of the tympanum, 36 contained extensive impressions, and in 32 the orbitæ were partially thin, partially perforated. The author concludes that absorption of the respective plates of bone takes place through pressure exerted by the brain, which pressure, however, cannot be more nearly defined. The form and quantity of the fissures vary ; their most frequent occurrence is above the head of the malleus, and somewhat farther toward the sutura petroso-squamosa.

In a third section he reports concerning a narrow, isolated

cartilage in the auditory meatus of a one-year-old child, subsequently also found in five other infantile cadavers of from three weeks to one and a half years of age. This cartilage is shaped like a hook, from one to one and a half centimetres long, and is situated at the anterior inferior wall in the membranous tissue forming the continuation of the cartilaginous auditory meatus. At times it is not fully isolated, but partly grown into the outward-pointing cartilage, leading the author to the belief that this is a preformation of Santorini's incisure. Two plates, containing drawings of petrous bones by the author, are appended to the text.

According to Zuckerkandl (*2 a*), the origin of atrophy of the petrous bone is favored by intracranial pressure caused by hydrocephalous, hypertrophy of the brain, as well as by early synostosis of the sutures. Accompaning this condition, the bones of the skull are found thinned; the impressiones digitatæ, deep; the juga cerebralia, high and angular. Zuckerhandl distinguishes four degrees of atrophy of the petrous bone. The first shows the upper surface smooth and thin; the semi-circular arcs project as distinct ridges. The second degree is characterized by a greater convexity of the posterior surface, as the bony tissue before and behind the internal auditory meatus atrophies considerably, thereby obliterating the anterior limiting edge of the fossa sigmoidea. In the third degree of atrophy, the convexity of the posterior wall has increased still more; the region of the semi-circular canals forming the limiting edge of the sulcus. Finally, in the highest degree of atrophy, the background of the meatus auditorius internus is fully exposed; the sagittal and frontal semi-circular canals become very prominent and show dehiscences. Senile atrophy of the petrous bones, as well as that caused by hydrocephalus, only lead to the lighter degrees. In all cases, the posterior surface of the petrous bone is most deeply affected.

Zuckerkandl (*2 b*), found formation of fissures in the posterior wall of the auditory meatus in three petrous bones. In the first, the fissure extended through the whole length of the wall, leading into the cavity of the tympanum and into the cells of the mastoid process. The second preparation was in a similar condition. In the third, the fissure, widening toward the interior, extended to the limit between the external and middle third of the auditory meatus, and led into the upper cells of the mastoid process, all three petrous bones lacked the spina supra meatum. Zuckerkandl takes the fissure-formation to be congenital, and refers it to a per-

sisting patulous condition of the juncture of the *épitympanique* (as the French call it) with the squama of the temporal bone.

(2 *c*) 1. Description of the left petrous bone of a new-born showing several traces of arrested development. The Fallopian canal extended as an open furrow to the second flexure, then formed a sinus open toward the cavity of the tympanum, and finally formed a sulcus ending at the foramen stylomastoideum. The passage of the acusticus commenced as a small fissure and ended with a tractus foraminulentus, which corresponded only to about one-third of the normal size. The tympanic cavity showed no foramen ovale, no promentorium, no eminentia pyramidalis, but only a cavity in the wall of the labyrinth, at the bottom of which there was a fissure-like opening into the cochlea. The latter, as well as the vestibule, are only half the size of those of the new-born. From within the vestibule may be seen a thin plate of bone, plainly differentiated, corresponding to the plate of the stapes, surrounded by a delicate white wall, as if a synostosis of the plate of the stapes with the wall of the labyrinth had taken place. The author refers to Rüdinger's and Gruber's investigations concerning the formation of canals in the temporal bone, and the development of the stapes from the wall of the labyrinth, and hence considers the present case as one of arrested formation.

2. Absence of calibre of the external auditory meatus and the cavity of the tympanum in the right petrous bone of a man aged 40. The occluding bony mass contained inferiorly a small fissure leading into a canal 1 *cm.* long, 2 *mm.* broad, and 2 *mm.* deep. Abscence of membrana tympani, ossicles, and canal of the tensor tympani; the bony canal of the tube was present to the length of 1 *cm.* The bony labyrinth was normally developed.

3. Considerable stenosis of the fenestra rotunda in both petrous bones of a man. The fenestræ would only admit the introduction of a bristle. In place of the eminentia pyramidalis a deep cavity, communicating with the Fallopian canal was found. The temporal region, situated behind the sulcus tympani, was greatly swollen and overlapped the sulcus anteriorly, so that Zuckerkandl thinks an otoscopical diagnosis of this bony prominence possible.

(3.) Referring to the investigations of Bürkner* and Jänicke,†

* *Archiv. f. O.*, Bd. XIII, p. 125.

† Contributions to the Anomalies of the Base of the Skull. On Thinning and Perforation of the Tegmen Tymp. Inaug. Diss., Kiel, 1877.

Flesch states that these authors agree on the frequent concurrence of dehiscence of the tegmen tympani with thinning and perforation in other parts of the skull. While Bürkner, however, assumes as cause, in the greater majority of cases, pressure exercised by the brain, Jänicke considers most of the defects as congenital, a large number as due to senile atrophy, and saw in one case thinning of the tegmen as well as of the base of the skull due to a high degree of hydrops ventriculorum with closure of all cranial sutures. Hyrtl's hypothesis, that pregnancy, as well as frequent blowing of the nose, favor dehiscence, is stated by Jänicke as improbable; likewise, its frequent origin in Pacchioni's granulations. Subsequently eleven macerated skulls, or their petrous bones, from the Würzburg collection are described, concerning the details of which the original should be consulted. The author then turns to the consideration of Jänicke's assumption, that the dehiscences are mostly congenital. The small percentage (7.6) between the ages from one to twenty years,‡ given by Jänicke, contradicts this theory; the percentage in later years rising to from three to five times that number. Flesch examined 61 temporal bones of the new-born, and found in but one of them three somewhat larger apertures, disregarding as foreign to this subject the segmentation of the point of the tegmen tympani into an intercalary bone. The roof of the cavity of the tympanum, besides, does not belong to the absorption-surfaces of the temporal bone (Kölliker), but appears to the author to be classifiable among the opposition-surfaces, judging from some experiments of feeding animals on madder. Hence, any fissures occurring in infancy would be closed later, and the percentage of dehiscences should diminish rather than increase with age. Flesch agrees with Jänicke respecting the simultaneous occurrence of fissures with expansion of the frontal and other pneumatic cavaties; while he dissents from Hyrtl's hypothesis regarding pregnancy. Perforations caused by Pacchioni's granulations seem to occur rarely in the tegmen itself, inasmuch as they rarely cross the fissura petrosa-squamosa. The effects of pressure, then, would seem to be the most frequent cause of perforations. The roof of the orbital cavity and the lamella above the malleo-incudal joint are particularly exposed to

‡ Jänicke says, however, that the majority of instances belonging to this class are new-born or very young children, in whom the whole pyramid is still but little developed and firmly attached to the dura mater, so that with them the condition of the tegmen tympani is difficult to determine.

pressure, on account of the vicinity of firm structures not permitting an apposition from within the cavities, which might counterbalance the absorption by intracranial pressure. Result: 1st. The dehiscences are the consequences of processes of absorption, and certainly only in exceptional cases congenital. 2nd. In the large majority of cases, increase of pressure within the cranial cavity is the cause of the absorption. 3d. Extensive development of the pneumatic cavities favors the consummation of the perforation.

Historical Supplement of the Reviewer.

For the sake of the historical interest, it may not be amiss in this place to remember Valsalva's views on the dehiscences.* Valsalva must have frequently seen them, for he inclines to consider them as normal apertures. Where he failed to see them, he often succeeded, by injections through the tubes, to force fluids through the roof of the tympanic cavity, and where even this no longer occurred he believed that the narrow canaliculi had been closed by mucus or the formation of valvules. After describing the fenestræ rotunda and ovalis, he says that he had discovered, besides these well-known openings, new apertures in the tympanic cavity, the situation of which would be found above the mastoid cells, predominantly above the malleo-incudal joint, but also more anteriorly. Although again doubting whether they had been intended by nature, on account of the frequent absence of the fissures, he still believes to have found a solution, very welcome to physicians, of the enigma as to how aggregations of blood or pus may gain egress from the cranial cavity, and in reference thereto, adduces the results of two autopsies. In the fifth chapter he again recurs at length to the new foramina, discusses their advantages under normal conditions—namely, that the cerebral fluid flowing through them moistens the membrana tympani and thereby preserves its vibratory power; further, that in penetrating wounds of the skull and the formation of abscesses, during the condensation of the air which has been named after him, pus flows more freely from the wound, respectively the auditory meatus; and, finally, he recommends to physicians to apply inhalations in apoplectics to the nostril opposite to the paralyzed side. Morgagni † likewise treats fully of Valsalva's foramina, coinciding with his teacher, although he would limit their occurrence

* A. M. Valsalvæ Tractatus de aure. Venetiis, 1741. Cap. II, 14.
† J. B. Morgagni Epistola anatomica, VI, p. 208.

and advantages. Moreover, Hyrtl ‡ after speaking of the conduction of the inflammatory process from the tympanic cavity into the interior of the skull, says: "The apertures in the tegmen tympani, on the other hand, may cause intracranial abscesses to empty themselves into the tympanic cavity, and to reach the exterior through the disintegrated membrana tympani." Valsalva is not mentioned in this connection.

Gribbon (4) describes a case of purulent otitis media dextra with destruction of the membrana tympani in a soldier, æt. 22, who complained shortly before death of violent headache, nausea, and weakness of the lower extremities. On raising the patient, there was a profuse discharge of pus from the right ear, followed by sudden death. On section, the cerebellum showed a large abscess cavity which had completely destroyed the right lobe, a thin membrane excepted, as well as the vermiform process and the left lobe in part. The perforation had occured in the region of the right meatus auditorius internus; here the petrous bone and the mastoid cells were filled with pus. The abscess probably had existed for some time, but there were no symptoms present which could have indicated so grave an affection.

Böttcher (5) already proved in the twelfth volume of Virchow's Archiv. the frequent occurrence of concretions of phosphate of lime in the periosteum of the internal auditory meatus, said to be most frequent in its fundus. They are not to be looked upon as senile productions, but are found already in persons of middle age. They are homogeneous or concentrically laminated bodies, of globular, oval or club shape and whitish-yellow color. The bodies are homogeneous when they, situated at the inner surface of the meatus, are allowed free development and growth; in the firm tissue of the periosteum they are surrounded by layers of connective tissue. Reaction on muriatic acid. Moos (5) found these concretions not infrequently. On dissection of a deaf-mute (ARCH OF OPHTH. AND OTOL., II, i. 139), they were found in the periosteum of the porus acust. int., in the neurilemma of the acusticus, and on the membranous saccules of both vestibules. Fester (clinical contributions to the Psammoma of the Central Nervous Apparatus, *Berl. Klin. Wochenschr.*, No. 8, 1878) describes three cases of fibro-psammoma, two of which concerned the acoustic and facial nerves. In the one case, the acoustic nerve

‡ On Spontaneous Dehiscence of the Tegmen Tympani and Cellulæ mast. Sitzungsbericht der Kaiserl, Akademic, etc., June 17th, 1858.

was atrophic, in a state of fatty degeneration, containing concrements in the thickened neurilemma; in the second case, the nerve itself showed such deposits between the still remaining thin and atrophied fibres. The corpuscles could be traced into the cochlea and semi-circular canals, thus permitting conclusions as to the peripheral commencement of the neoplasm with centripetal development. Moos, on examining the petrous bones of a woman, æt. 44, accidentally found concretions of phosphate of lime in the body of both auditory nerves, while transverse sections of the same were examined for hemorrhagic infiltration of the sheath. Moos had examined the patient two years before. She was very hard of hearing, dated her affection three years back, could only converse by means of an ear-trumpet, and was excessively annoyed by subjective noises. Bilateral hyperæmia of the vessels of the handle of the malleus; tubes patent. Bone-conduction for watch and tuning fork no longer present. Suspected labyrinthine trouble. Further treatment declined, it having been fruitlessly attempted by others. Beginning of July, 1877, suicide by drowning. The report of the house physician showed that patient had suffered from insomnia, neuralgic pain in various parts of the head, as well as from hyperæsthesia of the scalp. Latterly, weakness of sight, injection of the conjunctiva. At times fever up to 39° C., exhausting hyperhidrosis. Section of the petrous bones by Moos: Mucous membrane of posterior wall of pharynx hyperæmic. Right tube with difficulty, left tubes easily permeable. Dura mater throughout firmly united to the hyperostotic petrous bone. Right, marked hyperæmia of the vessels of the manubrium and of the whole middle ear and the mastoid cells; some serum in tympanic cavity. Left, the wall of the labyrinth only hyperæmic. Internal muscles on both sides normal; malleo-incudal and incudo-stapedeal joints slightly movable; mobility of the stapes impaired. Vestibules narrowed by hyperostosis; membranous semi-circular canal satrophic. Numerous concretions of phosphate of lime in the neurilemma and the body of both acoustic nerves. The left acusticus, on transverse section, showed recent hemorrhages. Interstitial neurilemma thickened. Discrete concretions likewise in the lamina spiral. membran. of the left cochlea. Remarks: 1. The manner of death may perhaps explain the hyperæmia—excepting that of the left labyrinthine wall—as well as the hemorrhagic infiltrations. 2. The sclerosed condition of the petrous bones is a partial demonstration of the pachymeningitis proved by the house physician by

the autopsy. 3. The sclerosis of the middle ear was the oldest metamorphosis, inducing impaired hearing and increased pressure in the labyrinth. 4. The subjective auditory sensations were materially increased by the development of concretions of phosphate of lime in the body of the acoustic nerve, inasmuch as these deposits must be regarded as pathological, continuously acting, mechanically tetanizing apparatuses.

H. Munk (6) reports on a case of unilateral absence of all semicircular canals in a pigeon—"turning" pigeon, so called. There was a faulty carriage of the head which appeared turned, as compared with the normal, 90° degrees around the sagittal axis, and 45° around the vertical axis toward the left. The right eye was directed straight downward, the left eye straight upward. The bill was turned to the left and anteriorly; the back of the head to the right and backward. This carriage of the head remained unchanged and quickly returned after forcible alteration. Standing and slow walking were normal. Walking was never performed in a straight line, but in a large curve toward the left, therefore *mouvements de manège* to the left Flying was impossible. In feeding, the pigeon struck to the left forward and downward. Under observation six months. Autopsy: Posterior muscles of neck normal. In the petrous bone, posteriorly to the right, there was a depression of 7–8 *mm.* in diameter. Bony wall thinner than normal. *No trace of semi-circular canals.* Left, everything normal. Tympanum and cochlea normal on both sides. No abnormity in the cerebellum and the processus mesootici. Acustici not yet examined at time of report.

According to Munk, only the faulty carriage of the head can be attributed to the abscence of the semi-circular canals as *primary* consequence. All other appearances are *secondary*, deducible from the faulty carriage of the head.

II. PHYSIOLOGY OF THE ORGAN OF HEARING.

By OSCAR WOLF, of Frankfort-on-the-Main.

Translated by Isidor Furst, of New York.

1. J. Gavarret, Professeur de la Faculté de Médicine de Paris. Acoustique biologique. Phénomènes physiques de la phonation et de l'audition. [Biological Acoustics. Physical Phenomena of Phonation and Audition]. Avec 100 Figures dans le texte. Paris: G. Masson, 1877.

2. Dr. Arthur Hartmann, of Berlin: "Eine neue Methode der Hörprüfung mit Hilfe electrischer Ströme." [A new Method of Testing the Hearing by the aid of Electric Currents]. *Archiv. für Physiologie* von E. du Bois-Reymond. Leipzig: Veit & Co., Jahrg. 1878.

3. Albert Wodtke, M.D., of Dantsic: "Ueber Hörprüfung mit besonderer Berücksichtigung der Methode mit Hilfe electrischer Ströme." [On Hearing-tests with special Reference to the Method by the aid of the Electric Current]. Inaugural Dissertation. Rostock: Universitäts-Buchdruckerei, 1878.

4. Prof. E. Berthold, of Königsberg: "Optische Darstellung der Schwingangen, welche durch das Telephon erzeugt werden." [Optical Representation of the Vibrations produced by the Telephone]. *Monatsschrift für Ohrenheilkunde*, June, 1878.

In the preface, wherein J. Gavarret (1) gives a definition of the object and contents of his book, he places the following sentence at the head: "The present publication, intended for our audience and pupils, is devoted to the study of the interesting question of biological physics. Without even for an instant straying from the experimental path or the elementary form, we have endeavored to maintain this monograph at *the level of science.*"

Then follows a short synopsis of the contents of the several chapters: The first three treat of the origin and the propagation of sound waves, the velocity, refraction, and reflection of sound; further of musical intervals, the scale, partial tones, and the manner of vibration of gaseous, solid, and liquid bodies. The fourth chapter treats of the doctrine of interference of sound, and of the faculty of the ear to analyze composite sounds; the fifth chapter treats of the doctrine of resonance, the sixth of the timbre of tones; the seventh and eighth chapters contain studies on the physical and physiological phenomena of voice-formation and hearing (phonation et audition). If, in reading this work, we try to find out what M. Gavarret means by "level of science," we look in vain for anything new, in the whole book, or anything particularly valuable to the physiology of speech and the ear. The book is a compilation—we admit, a very clear and clever one—of various text-books of physics, and particularly of Helmholtz's "Lehre von den Tonempfindungen."

Although it may be very flattering to German investigators to be thus acknowledged by French authors, it is on the other hand to be regretted that so capable an academical teacher as Gavarret in

the year 1877 only knew those works which had been translated into French up to the latter part of 1869. Hence the results obtained within the last ten years by Böttcher, Buck, Blake, A. Fick, Goltz, Lucæ, Mach, Magnus, Moos, Preyer, the Reviewer, and others, based on the publications of Helmholtz and Donders, must for the present remain unknown to the French reader. Illustrations and texts are chiefly borrowed from the following works: Joh. Müller, Manuel de physiologie, traduction de Jourdan, 1845; Helmholtz, Théorie physiologique de la musique, traduction de Guéroult, 1868; Tyndall, le son, traduction de l'abbé Moigno, 1869. The only thing new is the illustration of Scott's phonautograph (also used as vignette on the title-page) which, however, is already superseded by Edison's phonograph.

In the seventh session of the Physiological Society of Berlin, Dr. Arthur Hartmann (2) demonstrated "a new method of testing the hearing by the aid of electric currents," and Mr. Albert Wodtke, incited by this lecture, has followed with further investigations, the results of which he has laid before us in his inaugural dissertation. It would be more correct to call the method reported by Hartmann "testing the intensity of sound," and not "testing the hearing," for in the main it rests on the principle: "to measurably graduate the intensity of the sound produced by an apparatus."

This graduation Hartmann attempts to secure by the following arrangement: A regularly interrupted electric current is directed to a telephone, in which as many variations in magnetism, and consequent vibrations of the diaphragm, are induced as there are interruptions, producing on the applied ear the effect of a loud tone. The diminution of the current produces a lower, the increase of the current, a greater intensity of tone. The regular interruption of the current is effected by a Helmholtz's intermitting tuning-fork; the diminution, by a rheostat or by the aid of a sledge induction apparatus; the tuning-fork in question is maintained in vibration by two Daniell's elements. For the application of induced currents as telophone exciters, the interrupting fork is included in the primary circuit of a Du Bois-Reymond sledge-inductorium, whose secondary spirals are joined to the receiving telephone by wires of 20 metres in length; on removing the secondary spirals from the primary ones, the tone in the telephone decreases in analogy to the intensity of the currents.

Thus far Hartmann's communication.

Wodtke (3) sought to utilize Hartmann's idea for the purpose of otology, particularly the testing of the acuity of hearing, and accordingly modified the apparatus in the following manner. Considering that the current produced by the Daniell elements is generally of inconstant intensity, Wodtke used a thermo-electric chain, the current of which keeps the fork *uniformly* vibrating, as long as the flame heating the chain is always kept at the same height. The ear-piece of the telephone was modified in such a manner as to imitate the end-piece of the otoscope. This modification has the advantage of excluding bone-conduction in experiments with ear patients, for when the otoscope-like end-tube was closed above, and held to the temple, the mastoid process, or between the teeth, no tone was audible. For the graduation of the intensity of the tone the small sledge-inductorium was employed, whose secondary spirals could be separated from the primary ones to the distance of 57 centimetres. Opening and closure of the circuit afforded a ready means of preventing self-deception, and still more, to guard against false representations of patients during hearing-tests that were to be instituted. When the apparatus is in operation, its intensity of tone is proportionate to the square of intensity of the electric current. The hearing-tests were instituted in such a manner as to choose the greatest intensity of tone first, and then reduce this by removal of the secondary spirals from the primary ones, until the patient represented that he ceased hearing; then the distance of the secondary spirals from the primary ones was measured. Then Wodtke started from such a distance at which the patient was sure not to hear anything, and proceeded with the approximation of the secondary spirals to the primary ones until he came to the point at which the patient stated that he heard; then again the distance was measured, generally yielding a difference from the first determined distance.

Finally Wodtke made comparative experiments on 25 patients, between their perceptive powers for the tone of the telephone, the watch, and Politzer's acoumeter, yielding more constant results in favor of the telephone than with either watch or acoumeter.

Thus far the groundwork of Wodtke's facts. If we now consider his experiments in a theoretical direction, they at least yield the valuable result that by their aid the approximate measurement of the *intensity* of a tone seems to have been accomplished for the first time. This achievement being of importance for physical acoustics, it remains in so far significant for the physiology of the

ear as it permits us to search out the perceptive capacity for the faintest tone. But when Wodtke says, at the end of his dissertation: "This assertion seems to me permissible, that this method, in which everything is based on law, which avoids the shortcomings attaching to so many other methods, is in the way of satisfying *every* demand made of a *satisfactory* acoumeter," then the Reviewer would desire to repeat the demands made by him some time ago (ARCHIVES OF OPHTH. AND OTOL., IV, p. 68), which the busy practitioner even to this day has to make of a hearing test sufficing for diagnosis and prognosis, namely: it must admit of quick performance, lest it take up too much of the time and patience of physicians as well as of patients; it must be accurate, *i. e.*, it must compass, if possible, the series of tones occurring in human intercourse; it must finally be so uniform and comprehensible as possible for all patients and for all repetitions of the test. Wodtke's method in question at best fulfils only the latter requirement, and this only if it should be possible *always to develop* an equally strong electric current. But the Reviewer must doubt even this; a thin layer of oxide at a place of junction weakens the current considerably; now let us imagine the physician examining the condition of the thermo-electric chain previous to his hours of consultation to enable him to make a hearing-test—it would take a great deal of time; nor would it be possible for him to take the thermo-electric chain and the intermitting tuning-fork with him to the house of his patient.

If we inquire further, what would be gained by testing according to this method, how distinctly a patient perceives a single tuning-fork tone, c°, and how its intensity appears changed after treatment? Hardly anything more than what the usual tuning-fork test shows. In all those alterations which exhibit an unequal perception for different tone-groups—and they are by far the most numerous—in all these, by the aid of the method described, we utterly fail to obtain a clear or precise representation of the affection.

But if we, instead of a Helmholtz's or König's tuning-fork (which latter was used by Wodtke), employed a whole series for hearing-tests, the acquirement and keeping in repair of so complicated an apparatus would be hardly possible to the practitioner. The Reviewer then cannot grant any material advantage to this method over that in use thus far (quantitative and qualitative test of speech, watch and Politzer's acoumeter), and he believes not to

err in thinking its general introduction into practice improbable, however interesting the experiments of Hartmann and Wodtke may be in a theoretical point of view.

Prof. E. BERTHOLD'S (4) communication on the optical representation of the vibrations produced by the telephone is in so far in connection with the researches just discussed (2 and 3) as Wodtke made his investigations at Berthold's clinique, witnessing Berthold's experiments with the telephone. Berthold (4) hermetically joins the ear-piece of a telephone to a T-shaped glass tube. One of the three ends of this tube is within the tube attached to the ear-piece of the telephone; the second end is connected with a gas tube by an india-rubber hose, and the third end is drawn out so as to give a small vertical flame with the gas escaping from it. The well-known prismatic, rotating mirror serves for the observation of the flame; a quietly burning flame shows therein a horizontal line of light, whose breadth corresponds to the height of the flame. If now the conducting wires of the telephone were connected with an intermitting current, distinct wave-motions showed themselves in the rotating mirror, and these wave-motions became still more distinct on connecting a König's intermitting tuning-fork as tone-producer with the telephone. In these experiments the fact was surprising that the tones of a violin and of loudly articulated vowels spoken into the mouth-piece of the telephone, produced barely any alteration in the line of light, while they still remained very distinctly audible in the ear-piece of the telephone. For this reason Berthold employed this test for the experimental proof of *the degree of sensitiveness with which our ear reacts on tones;* he inserted a stopper-rheostat between tuning-fork and telephone, in order to cause the loud tone produced by the intermittent tuning-fork in the ear-piece of the telephone to disappear. It was thereby shown that it was not possible to entirely extinguish the tone in the telephone with a resistance of 2,110 Siemen's elements—the strongest possible, by means of the rheostat. But on observing the image of the flame in the rotating mirror during the insertion of rheostat, there was only a faint wave-line visible in the mirror, with a resistance of but 100 Siemens elements; with a resistance of 200 Siemens elements, only the band of flame was visible, but no motion thereof. Berthold concludes from this fact that *our ear* is more than *ten times as sensitive a reagent for tones than an ever so easily movable gas flame.*

(TO BE CONTINUED.)

III. EMBRYOLOGY AND COMPARATIVE ANATOMY OF THE ORGAN OF HEARING.

By L. LÖWE, of Berlin.

Translated by Isidor Furst, of New York.

1. O. Hertwig and R. Hertwig: Das Nerven system und die Sinnesorgane der Medusen. [The Nervous System and the Perceptive Organs of the Medusæ]. Leipzig: Engelman, 1878.

2. L. Löwe: Ueber Entstehung des knorpeligen knochernen Labyrinths. [On the Origin of the Cartilaginous and Osseous Labyrinth]. *Ber. d. Münchener Naturf. Vers.*, 1877, p. 343.

3. L. Löwe: Ueber die Anfänge der Ohrmuschelbildung by einem menschlichen Embryo von 1 *cm.* Körperlänge. [On the Rudiments of Pinna-formation in a human Embryo of the Length of One Centimetre]. Archives of Otology, 1878, p. 196.

4. Kuhn: Untersuchungen über das häutige Labyrinth der Knochenfische. [Investigations on the Membranous Labyrinth of the Osseous Fishes]. *Arch. f. Mikr. Anat.*, Bd. XIV., 3, pp. 264–307. 4 Plates.

5. J. Gruber: Beitrag zur Entwickelungsgeschichte des Steigbügels und des ovalen Fensters. [Contribution to the History of the Development of the Stapes and the Fenestra Ovalis]. Schenck's Embryol. Mitth., Vienna, 1878, p. 167.

6. C. Reschreiter: Zur Morphologie des Sinus Maxillaris. Stuttgart. [On the Shape of the Maxillary Sinus]. Cotta, 1878, pp. 44, 2 plates.

8. Moldenhauer: Vergleichende Histologie des Trommelfelles. [Comparative Histology of the Membrana Tympani]. *Archive of Otology*, 1878, 1.

8. D. Hunt: A Comparative Sketch of The Early Development of the Ear and Eye in the Pig, together with a new Account of the Development of the Meatus Externus, Drum, and Eustachian Tube. Transact. of the International Otological Congress. Comp. *Amer. Jour. of the Med. Sciences* for January.

9. V. Urbanschitsch: Das Lumen des äuseren Gehöranges bei Embryonen und Neugeborenen. [The Calibre of the External Auditory Meatus in Embryos and the Newborn]. Schenk's Embryol. Mitth. Vienna, 1878, p. 431.

1. From the book of the brothers Hertwig (1) treating of the whole nervous system of the medusæ, the Reviewer selects only those paragraphs having reference to the organ of hearing. As is

well known, medusæ are divided into two classes: Craspedota and Acraspeda, according to the presence of a muscular margin—the so-called velum—around the disc (hence Craspedota), or its absence (Acraspeda). In the first place, as regards the medusæ craspedotæ, those in the possession of an organ of hearing lack the organ of sight, and vice versa; so that these two perceptive organs seem to exclude one another. The brothers Hertwig first discuss that form of auditory organ found in the vesicularly margined medusæ or vesiculatæ (Mitrotocha, Tiaropsis). The simplest form of auditory organ in these animals consists of a series of open half-canals situated along the attached margin of the velum. Both epithelial layers of the velum take part in the formation of the canals. The epithelium of the upper side of the velum covers the thick convex surface of the half-canals, and in these places consists of large cells provided with a membrane and inclosing a quantity of fluid. The epithelium of the under side of the velum attaches to the concavity of the semi-tubes, and here mostly contains the concretions of lime. A row of cells along the inner margin of each channel assumes the form of a sensory epithelium, in which the cells on the one side, connect with the nervous ring by offshoots; on the other side, they develop auditory ciliæ. In the Mitrotocha, the brothers Hertwig have counted as many as eighty such auditory channels. In other vesiculates (Æquorea, Octorchis, Fucheilota, etc.), the open channels have transformed into closed sacculi. The latter stand in the same genetical relation to the former as the closed auditory vesicles of the full-grown vertebrates to the open half-canals of the vertebrate embryo.

In a second sub-genus of the craspedota, distinguished by their rigid gelatinous disc, and hence called Trachymedusæ, the organ of hearing appears in a totally different form and manner. Here it has the form of a modified tenacle, the simplest phase of which is a papilla, whose axis consists of a ridge of entoderm covered by an envelope of ectoderm. In the terminal cells of the entodermal axis there are some concretions of lime, and several cells of the ectodermal covering are metamorphosed into sensory cells provided with auditory ciliæ. In more complicated forms, the auditory papilla is inclosed in a cup-shaped circumvallation. Finally, in the most complicated formation of the geryonia, the cup is transformed into a closed vesicle.

In the acraspeda, too, the prevailing type of the auditory organ

seems to be the modified tentacular form. The latter is most generally situated in an excavation of the lower surface of one of the segments of the disc, at its margin. The excavation may deepen into a canal. In the centre of the entodermal axis of the auditory tentacle is a prolongation of the gastro-vasicular canal-system ; the terminal knob of the entodermal axis contains concretions of lime. The ectodermal cells become cylindrical at the base of the auditory tentacle, acquire an auditory cilia, and connect with the nervous ring, whose ganglionic expansions they represent.

2. In rabbit embryos of a length from 7 to 8 *mm.*, according to Löwe (2), the first traces of a true cartilaginous tissue appear in the basis cranii. In earlier stages, the latter consist entirely of fœtal connective tissue. Two cartilaginous columns form first on each side, starting from the anterior margin of the chorda which extends only to the subsequent sella turcica. These parachordal cartilaginous shafts expand posteriorly and there form the anterior margin of the foramen occipitale. Anteriorly they consolidate in front of the chorda ; at their external margin the cartilaginous ear-capsules are situated. These, in the first stages, are in complete cartilaginous continuity of tissue with the parachordal cartilaginous columns. A large opening exists in the ear-capsules for the entrance of the acoustic nerve ; besides, there is a semicanal for the facial, and, thirdly, an aperture for the aquæductus. In immediate connection with the cartilaginous ear-capsule, the cartilaginous shaft for the first and for the second branchial arcs forms, so that the whole cartilaginous basis cranii at first is uninterrupted cartilaginous-tissue connection. But the later subdivisions into the isolated auditory ossicles, etc., are early marked by darker portions of tissue in the cartilage. The future organization then proceeds in this manner—while the entire cartilage ossifies, these darker portions of tissue remain unossified. Thus the cartilaginous basis cranii, originally cohering throughout and nearly homogeneous, breaks up into its component parts. The ear-capsule separates from the occipital vertebra, the stapes from the ear-capsule, the rest of the auditory ossicles from the stapes [comp. Gruber (5) and Hunt (8)].

3. In an embryo of a length of 1 *cm.*, according to Löwe (3), all essential parts of the pinna were already macroscopically unfolded, so that this structure appears earlier than the jointing of the foot, or the separation of the extremity into an upper and lower portion. The configuration of the pinna is pri-

marily traceable to the peculiar indentations ensuing in the entrance to the second branchial fissure, that is, the meatus auditorius externus.

4. Kuhn's researches were instituted on the auditory organ of the pike. In the first place, Kuhn confirms the existence of the two nerve-papillæ at the base of the utriculus, newly discovered by Retzius, so that now eight terminal nerve stations in the auditory organ of the osseous fishes are assured. Three of these are supplied, 1st, by the macula belonging to the recessus utriculi; 2nd, by the crista situated at the ampulla of the sagittal arch; and 3d, by the crista situated at the ampulla of the horizontal arch. The remaining five, however, namely, 4th, the macula sacculi; 5th, the crista lagenæ; 6th, the crista at the ampulla of the frontal arc; 7th and 8th, the two maculæ at the newly discovered papillæ partis basilaris, obtain their terminal nerve branches from the nervus cochleæ. The cristæ and the maculæ acusticæ are formed after the same type. The nerve-fibres, still surrounded by the marrow-sheath, pierce the cartilaginous supporting basis, upon which rests the auditory epithelium of the cristæ and maculæ. Immediately thereafter they lose their marrow-sheath and form an intra-epithelial nervous plexus between the auditory epithelial cells composed of three different elements. The lowest layer of the latter consists of round elements; then follows a layer of filamentous cells; upon these is a layer of ciliated cylindrical cells. The filamentous cells have a large nucleus and two processes: the upper either goes upward between the cylindrical cells, terminating free, or it approaches the basal process of a cylindrical cell; the lower process advances into a delicate nerve-fibre coming from the intra-epithelial plexus. The filamentous cells, then, are nervous terminal apparatuses, inclosed in the course of a nerve-fibre; the extruding fibre ends either free or at a cylindrical cell. In the latter case, the cylindrical cells are also in connection with nerve-fibres. Hence it still remains doubtful whether the vibrating citræ upon the terminal surface of the cylindrical cells are the last links of a nerve-ending. The entire auditory-epithelium is covered by a homogenous membrane remaining comparatively thin and flatly expanded upon the maculæ, but upon the cristæ swelling to a conical or fungi-form *cupula terminalis tectoria.*

According to Gruber (5), the stapes does not originate, as Reichert maintains, in the cartilaginous visceral stripe of the second visceral arc, but in the calvarian vertebra, that is, in the

same formative tissue from which the capsule of the labyrinth is developed. The author never found the plate of the stapes sufficiently separated from the wall of the labyrinth to justify the assumption that the union of the two occurs by the completed plate of the stapes entering into connection with the margin of the fenestra ovalis. The author's illustrations show that in no stage of development of the embryo is the finestra ovalis preformed for the reception of the plate of the stapes, but that it must be understood, as it were, as a state consequent on the separation of the plate of the stapes from the wall of the labyrinth. [Gruber's communications fully agree with the statements of the Reviewer (2) and of Hunt (8)].

Reschreiter (6), a pupil of Rüdinger, has investigated the growth of the superior maxillary bone and the origin of the sinus maxillaris. The first outline of the sinus maxillaris shows itself in the lateral nasal cartilage; in the third or fourth month we observe a furrow in the bone caused by the elevation of a lateral and interior wall; the demarcation is already distinct, but interiorly it becomes so only in the sixth or seventh month. Both limiting walls close anteriorly in the seventh to eighth month; the interior wall gradually attaches itself posteriorly close to the bone; the exterior wall curves inward and becomes the superior, then posteriorly downward and thus becomes the posterior; the angle between posterior and inferior with the adjoining parts of both, is the last to be developed. In consequence of these conditions and by lateral growth, the sulcus becomes an elongated oval sinus, the largest diameter being antero-posteriorly, the smallest, from without inwards. The vertical diameter of the sinus can increase only with the elevation of the floor of the orbita above the alveoli; below the infra-orbital canal the cavity cannot yet expand outwardly, hence the vertical and horizontal diameters progress apace. The growth of the body of the maxillary bone, and with it of the sinus maxillaris, is dependent, preeminently, upon the appearance, course, and termination of the second dentition. For the sinus does not expand correspondingly as the maxillary bone lengthens or widens, directly following its growth; but according as the teeth descend sooner or later into the alveoli, so that the spongy osseous tissue may then be re-absorbed. Ordinarily, the incisors first emerge, then the cuspids next the anterior molar, then the posterior molars, and the size of the maxillary cavity increases accordingly. Hence, the absolutely and

relatively small vertical diameter, until the last molar has emerged. The antero-posterior diameter also increases thereby, because the maxillary bone is pushed forward by the tooth inserting itself between its predecessor and the adjoining bone, thus affording the sinus room to expand in this direction too. The size of the entrance grows particularly in the diameter from above downward, less in the one from behind forward. The sinus maxillaris has reached its complete development after the breaking through of the wisdom tooth. The sinus maxillaris of the man is distinguished from that of the woman by its regular form, by the size and shape of its anterior surface, but especially by its projecting downward above the level of the nasal cavity.

Moldenhauer (7) gives a review of the structure of the membrana tympani of amphibia, reptiles and birds. Of amphibia and reptiles, bactrachians, tortoises and lizards were examined; of birds, hens, geese and ducks. The drum of frogs consists of a membrana propria, covered externally by the epidermis, internally by the mucous membrane. The external skin continues in all terminal layers to the membrana tympani, and is even provided with dermal glands and numerous pigment cells. The membrana propria, springing from the cartilaginous wall of the drum cavity, consists in its marginal portion of a radially disposed organic muscle; beyond, of filamentous radiating fibres which are found particularly distinct near the centre. The epithelium of the tympanic cavity is a cylindrical ciliated epithelium, which changes to a polygonal pavement epithelium within the confines of the membrana tympani. The membrana tympani of tortoises is similarly arranged as that of frogs as respect the memous layer, except that the glands are absent. A disciform expansion of the columella takes the place of the membrana propria. This cartilaginous disc is fastened by a circular band to the margin of the tympanic cavity, and interiorly is covered by teeth-like extensions of connective tissue, as well as a polygonal pavement epithelium. The membrana tympani of lizards is extremely delicate, but three layers may also be distinguished: 1st, the pigmental dermal layer; 2nd, a thin filamentous layer of radial fibres; and 3d, the polygonal epithelial layer. Near the membrana tympani the columella divides into several cartilaginous branches, one of which extends from behind and above to the centre of the membrana tympani, causing a slight convexity outward. The membrana tympani of birds is likewise very delicate,

and in it, too, three layers may be recognized. The membrana propria consists of a radial layer and fibrous extensions terminating in the direction of the tendons. Near the membrana tympani the osseous columella becomes cartilaginous and divides into three branches, the longest of which bends almost at a right angle, and terminates toward the centre. The sound waves striking the membrana tympani act on a bent lever, the hypomochlion of which is situated at the rim of the membrana tympani, and by which one margin of the columella disc is pressed more deeply into the vestibule than the other. A rotation occurs coincident therewith. Different from the human membrana tympani, that of birds is strongly curved outward.

8. According to Hunt (8) the first maxillary fissure does not remain open, but closes again with the exception of a slight depression. From here the meatus externus forms by alterations of growth and the deepening of the cavity ; while the tube originates in a new depression from the direction of the pharyngeal mucous membrane. The canal of the tube grows toward the meatus, so as to assume a position below the latter. Between the two canals a membranous mass of tissue, the membrana tympani, remains. The stapes forms in connection with the wall of the vestibulum [See Gruber (5) and Reviewer (2)].

In many animals, according to Urbantschitsch (9), the external ear at the origin of the pinna closes completely for a time. The pinna takes part in the closure of the auditory opening in various ways, namely, either the pinna occluding the auditory orifice remains in this position for several days after birth (mouse), or it detaches itself from the auditory orifice while still in embryonal development (rabbit). The manner of closure of the auditory orifice by the concha differs besides in various animals in this respect, that either the margins of the inverted upper half of the auricle simply join to the margins of the lower half (*e. g.*, mouse, hare, cow, cat), or else the margins of the lower section of the auricle, rolled inward, run into each other (rabbit, pig). In the new born human being, there is no epithelial adhesion present, but a complete apposition of the walls of the auditory meatus takes place. As regards the further development of the calibre of the external auditory meatus of man, it seems that an air-inclosing space forms first at the entrance to the auditory canal, and at its inner end at the membrana tympani. At least the author observed, in longitudinal sections through the external meatus of

children several weeks old, that the external meatus consists of two funnels expanding externally and internally, the narrow portions meeting at the junction of the cartilaginous and the membranous parts of the auditory meatus, at which place the walls are still in direct mutual contact. It is only during further growth, with simultaneous greater development of the canals, that the walls at this place also separate throughout from each other, and an isthmus is seen which is found less pronounced in the succeeding years of life, and which, as is well known, exhibits individual variations in the adult.